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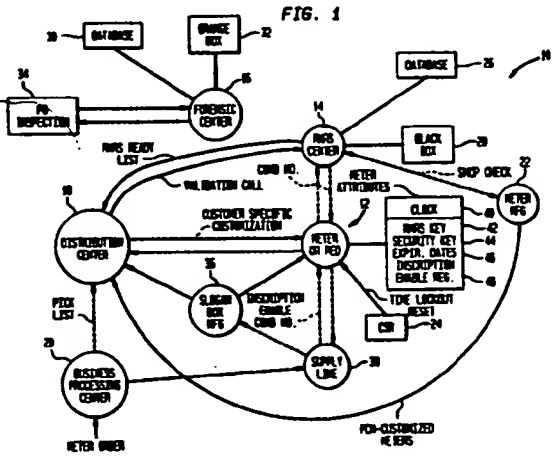
(54) Enhanced encryption control system for a mail processing system having data center verification

(57) A key control system comprises the generation of a first set of predetermined keys K_{pred} which are then used as master keys for a plurality of respective postage meters (12). The keys are then related to a respective meter (12) in accordance with a map or algorithm. The predetermined master key K_{pred} is encrypted with the date to yield a date dependent key K_{dd} related to the respective meter (12). The date dependent key is encrypted with a unique identifier or the respective meter to yield a unique key K_{final} that is by the respective meter to generate digital tokens. The Data Center (16) encrypts the date with each predetermined key K_{pred} to yield a table of dependent keys K_{dd}'s. The table of K_{dd}'s are distributed to verification sites. The verification site reads a meter's identification from a mailpiece being verified to obtain the dependent key K_{dd} of the meter (12). The verification side (34) encrypts the dependent key K_{dd} with the unique identifier to obtain the unique meter key which is used to verify tokens generated by the meter (12). In the preferred embodiment, the master key K_{pred}, the date dependent key K_{dd}, and the unique key K_{final}, in the meter are stored in the meter. In the alternate embodiment, the master key K_{pred} is encrypted with a unique meter identifier to obtain and the unique key K_{final} which is stored in the meter (12). The meter then generates its date dependent key K_{dd}, which is used to generate digital tokens.

FIG. 1



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Description

The invention relates to mail processing systems and methods and more particularly to security of postage metering systems.

Recent advances in digital printing technology have made it possible to implement digital, i.e., bit map addressable, printing for the purpose of evidencing payment of postage by a postage-meter-like device. Where necessary in order to distinguish such postage-meter-like devices from the typical postage meter, such devices will be called herein Postage Evidencing Devices or PED's. In such devices, the printer may be a typical stand-alone printer. The computer driven printer of such a PED can print the postal indicia in a desired location on the face of a mail piece. Further, as used herein the postal indicia will be defined as the Postal Revenue Block or PRB. The PRB typically contains data such as the postage value a unique PED identification number, the date and in some applications the name of the place where the mail is originating. It must be noted, however that the term postage meter as used herein will be understood to cover the various types of postage accounting systems including such PED's and is not to be limited by the type of printer used.

From the Post Office's point of view, it will be appreciated that a serious problem associated with PED's is that the digital printing makes it fairly easy to counterfeit the PRB since any suitable computer and printer may be used to generate multiple images. In fact many of these new PED systems may be using printers that are able to print legitimate indicia which are indistinguishable from those printed by others that are printed without any attempt to purchase postage.

In order to validate a mailpiece, that is to assure that accounting for the postage amount printed on a mailpiece has been properly done, it is known that one may include as a part of the franking an encrypted number such that, for instance the value of the franking may be determined from the encryption to learn whether the value as printed on the mailpiece is correct. See for example, U.S. Patent Nos. 4,757,537 and 4,775,246 to Edelmann et al. as well as U.S. Patent No. 4,649,266 to Eckert. It is also known to authenticate a mailpiece by including the address as a further part of the encryption as described in U.S. Patent No. 4,725,718 to Sansone et al and U.S. Patent No. 4,743,747 to Fougere et al.

U.S. Patent No. 5,170,044 to Pastor describes a system wherein include a binary array and the actual arrays of pixels are scanned in order to identify the provider of the mailpiece and to recover other encrypted plaintext information. U.S. Patent No. 5,142,577 to Pastor describes various alternatives to the DES encoding for encrypting a message and for comparing the decrypted postal information to the plaintext information on the mailpiece.

U.K. 2,251,210A to Gilham describes a meter that contains an electronic calendar to inhibit operation of the franking machine on a periodic basis to ensure that the user conveys accounting information to the postal authorities. U.S. Patent No. 5,008,827 to Sansone et al, describes a system for updating rates and regulation parameters at each meter via a communication network between the meter and a data center. While the meter is on-line status registers in the meter are checked and an alarm condition raised if an anomaly is detected.

U.S. Patent No. 5,390,251 to Pastor et al. describes a mail processing system for controlling the validity of printing of indicia on mailpieces from a potentially large number of users of postage meters includes apparatus disposed in each postage meter for generating a code end for printing the code on each mailpiece. The code is an encrypted representation of the postage meter apparatus printing the indicia and other information uniquely determinative of the legitimacy of postage on the mailpieces. The keys for the code generating apparatus are changed at predetermined time intervals in each of the meters. A security center includes apparatus for maintaining a security code database and for keeping track of the keys for generating security codes in correspondence with the changes in each generating apparatus and the information printed on the mailpiece by the postage meter apparatus for comparison with the code printed on the mailpiece. There may be two codes printed, one used by the Postal Service for its security checks and one by the manufacturer. The encryption key may be changed at predetermined intervals or on a daily basis or for printing each mailpiece.

It will be appreciated that in order to verify the information in the PRB using the encrypted message, the verifier must first be able to obtain the key used by the particular meter. In trying to deal with mailing systems which may incorporate such encryption systems, it must be recognized that the meter population is large and subject to constant fluctuation as meters are added and removed from service. If the same key were to be used for all meters, the key distribution is simple but the system is not secure. Once the code is broken by anyone, the key may be made available to others using the system and the entire operation is compromised. However, if separate keys are used respectively for each meter then key management potentially becomes extremely difficult considering the fluctuations in such a large population.

European Patent Publication No. 0647924, filed October 7, 1994, and assigned to the assignee of the instant application, describes a key management system for mail processing that assigns one of a set of predetermined keys by a determined relationship to a particular meter, effectively allowing multiple meters to share a single key. The key management system includes the generation of a first set of keys which are then used for a plurality of respective postage meters A first key of the first set of key is then related to a specific meter in accordance with a map or algorithm. The first

key may be changed by entering a second key via an encryption using the first key.

It has been found that although the system described in European Patent Publication No. 0647924 previously noted and hereafter referred to a the "1000 key system" provides a manageable key management system, the system has multiple meters sharing the same key.

It is therefore an object of the invention to provide a key management system which provides the improved security 1000 key system and yet which will allow ease of key management in a very large system.

It is another object to provide a method for easily changing the keys for each meter in a manner that provides improved security and system wide tracking of the key changes.

In accordance with the present invention, a key control system comprises the generation of a first set of predetermined keys K_{pred} which are then used as master keys for a plurality of respective postage meters. The keys are then related to a respective meter in accordance with a map or algorithm. The predetermined master key K_{pred} is encrypted with the date to yield a date dependent key K_{dd} related to the respective meter. The date dependent key is encrypted with a unique identifier of the respective meter to yield a unique key K_{final} that is used by the respective meter to generate digital tokens. The Data Center encrypts the date with each predetermined key K_{pred} to yield a table of dependent keys K_{dd}'s. The table of K_{dd}'s are distributed to verification sites. The verification site reads a meter's identification from a mailpiece being verified to look up the dependent key K_{dd} of the meter from the distributed table. The verification site encrypts the dependent key K_{dd} with the unique identifier to obtain the unique meter key which is used to verify tokens generated by the meter.

In a preferred embodiment the method in accordance with the invention further comprises the steps of storing the master key K_{pred}, the date dependent key K_{dd}, and the unique key K_{final}, in the meter.

In an alternate embodiment the master key K_{pred} is encrypted with a unique meter identifier to obtain the unique key K_{final} which is stored in the meter. The meter then generates its date dependent key K_{dd}, which is used to generate digital tokens.

The above and other objects and advantages of the present invention will be apparent upon consideration of the following detailed description taken in conjunction with accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

Fig. 1. is a schematic view of a system which may be used in accordance with an embodiment of the invention;

Figs. 2a and 2b illustrates the information which may be printed in a first embodiment of a PRB in accordance with an embodiment of the invention;

Figs. 3a and 3b illustrate an alternative to the information shown in Fig. 2a and 2b;

Fig. 4 is a flow chart of the operation for providing keys in accordance with an embodiment of the invention;

Fig. 5 is a flow chart of meter operation in accordance with the preferred embodiment of the present invention;

Fig. 6 is a flow chart of meter operation in accordance with an alternate embodiment of the present invention;

Fig. 7 is a flow chart of data center operation in accordance with the preferred embodiment of the present invention;

Fig. 8 is a flow chart of the verification process;

Fig. 9 is a block diagram of the preferred embodiment of the present invention; and

Fig. 10 is a block diagram of an alternate embodiment of the present invention.

In Fig. 1, there is shown generally at 10 an overall system in accordance with an embodiment of the invention. In the embodiment illustrated, the system comprises a meter or PED 12 interacting with a plurality of different centers. A first center is a well-known meter-fund resetting center 14 of a type described, for example, in U.S. Patent No. 4,097,923 which is suitable for remotely adding funds to the meter to enable it to continue the operation of dispensing value bearing indicia. In accordance with an embodiment of the invention there is also established a security or forensic center 16 which may of course be physically located at the resetting center 14 but is shown here separately for ease of understanding. Alternatively, such a security or forensic center could be an entirely separate facility maintained by the Postal Authorities, for instance or two separate facilities may be maintained in order to provide levels of security, if desired. The dashed lines in Fig. 1 indicate telecommunication between the meter 12 and the resetting center 14 (and/or forensic center 16).

Typically there may be an associated meter distribution center 18 which is utilized to simplify the logistics of placing meters with respective users. Similarly, a business processing center 20 is utilized for the purpose of processing orders for meters and for administration of the various tasks relating to the meter population as a whole.

The meter manufacturer indicated at 22 provides customized meters or PED's to the distribution center 18 after establishing operability with shop checks between the manufacturer and the resetting center 14 and forensic center 16. The meter or PED is unlocked at the user's facility by a customer service representative indicated here by the box 24.

At the resetting center 14 a database 26 relating to meters and meter transactions is maintained. The resetting combinations are generated by a secured apparatus labeled here as the Black Box 28. The details of such a resetting arrangement are found in U.S. Patent

No. 4,097,923, herewith specifically incorporated by reference herein, and will not be further described here.

Database 30 and a secured encryption generating apparatus, designated here as Orange Box 32, are maintained at the security or forensic center 16. The orange box preferably uses the DES standard encryption techniques to provide a coded output based on the keys and other information in the message string provided to it. It will be understood that other encryption arrangements are known and the invention is not limited to the specific embodiment using DES encryption. The security or forensic center 16, wherever maintained, is preferably connected by telecommunication with any Post Office inspection station, one of which is indicated here at 34.

Further details are to be found in European Patent Publication No. 0647924, previously noted and specifically incorporated by reference herein.

Meter 12, as illustrated, includes a secure clock 40 that is used to provide a calendar function programmed by the manufacturer. The clock and calendar function cannot be modified by the user. Such clocks are well known and may be implemented in computer routines or in dedicated chips which provide programmable calendar outputs. Also stored within the registers of the meter 12 are a fund resetting key 42, security key 44, expiration dates 46 and preferably, an inscription enable flag 48. Preferably, in order to prevent the breaking of the encrypted messages to be printed by the postage meter, the security key 44 is changed at predetermined intervals as discussed below.

The security key 44 is used in conjunction with a DES encrypter in the meter 12 to provide an encryption of certain information in the PRB for each printing of the PRB on a mailpiece. At each printing operation, the entire encrypted message may be printed on the mailpiece. However, preferably the cipher, hereafter referred to herein as an ECODE (also referred to as a digital token) is a truncated ciphertext produced by DES encryption of the message based on postage information available to the meter. Verification at the security center consists of verifying that the encrypted information is consistent with the ECODE.

If automatic checking of the ECODE is desired, both the ECODE and the plaintext must be machine readable. A typical length of plaintext information is, for example only and not by way of limitation, the sum of the meter ID (typically 7 digits), a date (preferably 2 digits, suitably the last 2 of the number of days from a predetermined starting date such as January 1), the postage amount (4 digits), and the piece count for a typical total of 16 digits. Reading devices for lifting the information either from a bar-code on the mailpiece or as OCR are well-known and will not be further discussed.

A DES block is conventionally 64-bits long, or approximately 20 decimal digits. A cipher block is an encryption of 64 bits of data. It will be appreciated that other information may be selected and that less than the information provided here may be encrypted in other embodiments of the invention. It is however important to note that the information to be encrypted must be identical to that used in verification. To this end the plaintext message may include data which indicates the particular information which is encrypted. This may take the form of an additional character, additional bar coding or a marking on the mailpiece as may be found desirable.

If desired, a second ECODE could be printed using a DES key from a set of keys PS-DES known to the Postal Service. Alternatively the Postal Service could elect to manage its own set of keys as described in connection with the key management system described below.

In a first embodiment, as shown in Figs. 2a and 2b, the plaintext is encrypted using one of the keys from PS-DES. The Postal Service uses the same key from the set PS-DES to verify the message. A higher level of security is provided by the second ECODE.

In a second embodiment, two ECODEs are generated and printed on the mailpiece, one using a PS-DES key provided by the Post Service and the other using a Vendor-DES key provided, for example, by the manufacturer or security center. The Postal Service can then verify the message using its own code generating and key management system while the vendor can separately verify the validity of the message using the ECODE generated using its separate key system. Figs. 3a and 3b show the format of this second embodiment.

Fig. 4 shows an arrangement for managing meter master keys as disclosed in European Patent Publication No. 0647924, previously noted. First a large, fixed set of predetermined keys K_{pred}'s is generated, at step 400. As seen below, the system S in accordance with the invention comprises a set of pointers {p}, a set of keys indexed by the pointer {keyp} and a map F or generating algorithm from the set of meter ID's {M} to the set of pointers. Thus:

S = (F, {p}, keyp}) is the system

F: {M} --> {p}

and

F(M) = F(meter ID) = p

finds the pointer to the key for a given meter M.

Thus, returning to Fig. 4, as an example, the set of pointers {p} which may be the integers from 1 to 1000, are created from meter parameters, at step 405. The function F may be then chosen as, again for example, the DES encryption of meter ID using a DES key K, preferably truncated to three digits, at step 410 and a look-up table is generated, at step 415. It will be understood that other functional relationships may be chosen. The look-up table comprises a set of meter ID's and their assigned pointers. For the greatest security, it will be appreciated that the relationship between a pointer p and the corresponding key should not be easily discoverable nor should the relationship between the pointer and the meter ID. It will also be understood that the function F should be maintained in secret.

Referring now to Figs. 5 and 9, the preferred embodiment of the present invention is shown. At step 420, using the meter ID of a specific meter in the look-up table, the corresponding K_{pred} is stored in the meter. At step 430, a date dependent key K_{dd} is generated from the predetermined key K_{pred} by encrypting the date with K_{pred} to yield the K_{dd} for the meter. At step 435, a unique meter identifier, such as a meter serial number, is encrypted with the date dependent key K_{dd} to produce a unique key K_{final} for the meter. The meter generates digital tokens using its unique key K_{final}.

Referring now to FIGs. 6 and 10, an alternate embodiment of the meter operation is shown. At step 470, a unique meter identifier, such as a meter serial number, is encrypted with the predetermined master key K_{pred} to yield a unique key K_{final} for the meter. The unique meter key K_{final} is stored in the meter at step 475. K_{final} is used to generate a date dependent key K_{dd} in the meter by encrypting the date with K_{final} to produce date dependent key K_{dd}.

Referring now to Fig. 7, the data center operation for the preferred embodiment is shown. At step 450, the date is encrypted with each predetermined master key K_{pred} to yield a table of date dependent keys K_{dd}'s. At step 455, the data center distributes the table of K_{dd}'s to each of the verification sites for use in verifying digital tokens generated by the meters.

Referring now to Fig. 8, a verification process is shown using the key management system in accordance with an embodiment of the present invention. In order to verify a mailpiece, the meter ID number printed on the mailpiece is read at step 500. At step 510, using the meter ID number a date dependent key K_{dd} is found in the table of K_{dd}'s distributed by the data center. The key is found using the lookup table or algorithm F from the given meter number. At step 515, the identical unique meter data that was used by the meter to obtain the meter's unique key K_{final} is encrypted with the date dependent key K_{dd}. At step 520, the identical plaintext information used to create the ECODE is now encrypted at the security center using K_{final}, and the result is compared with the code printed on the mailpiece, at step 530. If there is a match at decision at step 540, the mailpiece is valid. If not the NO branch will trigger an alarm.

Returning for the moment to Fig. 2a and Fig. 3a, the Postal Service is able in these embodiments to obtain the PS-DES pointer directly from the indicia without using the process shown in Fig. 8. In the cases illustrated in Figs. 2b and 3b, the DES pointer is obtained by using a predetermined algorithm applied to the information printed in the PED ID as described in connection with Fig. 8.

While the present invention has been disclosed and described with reference to the embodiments disclosed herein, it will be apparent that variations and modifications may be made therein. It is thus, intended in the following claims to cover each variation and modification that falls within the true spirit and scope of the present invention.

Claims

1. A method for key management for controlling the keys used in encoding information to be printed on a mailpiece for validating the mailpiece, the method comprising the steps of:

   generating a plurality of keys K to obtain a fixed key set $K_{pred(1-n)}$;
   assigning one of said plurality of keys K_{pred} to a particular postage meter M (12) by means of a determined relationship associated with the postage meter (12), said relationship being derived as a predetermined function F(M) corresponding to the particular postage meter;
   encrypting said assigned key K_{pred} with a date to obtain an assigned date dependent key K_{dd}; and
   combining the assigned date dependent key K_{dd} with information unique to the particular postage meter M_{uni} to produce a final key K_{final} for the particular postage meter M, such that $K_{final}=f(K_{dd}, M_{uni})$.

2. The method of claim 1 wherein said determined relationship associated with the postage meter is a pointer p associated with the particular postage meter M, said pointer p being derived as a function F(M) corresponding to predetermined parameters of the particular postage meter M.

3. The method of claim 1 or 2 further comprising the steps of:

   encrypting a date with each K_{pred} in said fixed key set $K_{pred(1-n)}$ to yield a table of date dependent keys $K_{dd(1-n)}$; and
   distributing said table of date dependent keys $K_{dd(1-n)}$ to verification sites.

4. A method for key management for controlling the keys used in encoding information to be printed on a mailpiece for validating the mailpiece, the method comprising the steps of:

   generating a plurality of keys K to obtain a fixed key set $K_{pred(1-n)}$;
   assigning one of said plurality of keys K_{pred} to a particular postage meter M by means of a determined relationship associated with the postage meter, said relationship being derived as a predetermined function F(M) corresponding to the particular postage meter;
   combining the assigned key K_{pred} with information unique to the particular postage meter M_{uni} to produce a final key K_{final} for the particular

postage meter M, such that $K_{final}=f(K_{dd}, M_{uni})$; and

storing said final key K_{final} in the particular postage meter M.

5. The method of claim 4 further comprising the steps of:

encrypting said final key K_{final} with a date to obtain a date dependent key K_{dd} for the particular meter M; and

storing said date dependent key K_{dd} in the particular meter M.

6. The method of claim 4 or 5 wherein said determined relationship associated with the postage meter is a pointer p associated with the particular postage meter M, said pointer p being derived as a function F(M) corresponding to predetermined parameters of the particular postage meter M.

7. A method for key management for controlling the keys used in encoding information to be printed on a mailpiece for validating the mailpiece, the method comprising the steps of:

generating a plurality of keys K to obtain a fixed key set $K_{pred(1-n)}$;

assigning one of said plurality of keys K_{pred} to a particular postage meter M by means of a determined relationship associated with the postage meter, said relationship being derived as a predetermined function F(M) corresponding to the particular postage meter;

installing the assigned key K_{pred} in the particular postage meter M;

encrypting said assigned key K_{pred} with a date to obtain an assigned date dependent key K_{dd}; and

combining the date dependent key K_{dd} with information unique to the particular postage meter M_{uni} to produce a final key K_{final} for the particular postage meter M, such that $K_{final}=f(K_{dd}, M_{uni})$.

8. A method for key management for controlling the keys used in the verification of encoded information to be printed on a mailpiece, the method comprising the steps of:

generating a plurality of keys K to obtain a fixed key set $K_{pred(1-n)}$;

encrypting a date with each K_{pred} in said fixed key set $K_{pred(1-n)}$ to yield a table of date dependent keys $K_{dd(1-n)}$;

distributing said table of date dependent keys $K_{dd(1-n)}$ to verification sites;

reading plaintext information printed on a mailpiece, said plaintext information including a meter ID identifying a particular postage meter M;

finding a date dependent key K_{dd} corresponding to the particular postage meter M by means of a determined relationship associated with the postage meter, said relationship being derived as a predetermined function of said meter ID;

encrypting said meter ID with said date dependent key K_{dd} to obtain a final key K_{final};

encrypting at least some part of the plaintext information using said final key K_{final} to obtain a code;

comparing said code with encoded information printed on the mailpiece; and

validating the mailpiece when said code matches said encoded information.

9. A system for key management for controlling the keys used in encoding information to be printed on a mailpiece for validating the mailpiece, comprising:

means for generating a plurality of keys K to obtain a fixed key set $K_{pred(1-n)}$;

means for assigning one of said plurality of keys K_{pred} to a particular postage meter M (12) by means of a determined relationship associated with the postage meter (12), said relationship being derived as a predetermined function F(M) corresponding to the particular postage meter;

means for encrypting said assigned key K_{pred} with a date to obtain an assigned date dependent key K_{dd}; and

means for combining the assigned date dependent key K_{dd} with information unique to the particular postage meter M_{uni} to produce a final key K_{final} for the particular postage meter M, such that $K_{final}=f(K_{dd}, M_{uni})$.

10. A system for key management for controlling the keys used in encoding information to be printed on a mailpiece for validating the mailpiece, comprising:

means for generating a plurality of keys K to obtain a fixed key set $K_{pred(1-n)}$;

means for assigning one of said plurality of keys K_{pred} to a particular postage meter M by means of a determined relationship associated with the postage meter, said relationship being derived as a predetermined function F(M) corresponding to the particular postage meter;

means for combining the assigned key K_{pred} with information unique to the particular postage meter M_{uni} to produce a final key K_{final} for the particular postage meter M, such that $K_{final}=f(K_{dd}, M_{uni})$; and

means for storing said final key K_{final} in the particular postage meter M.

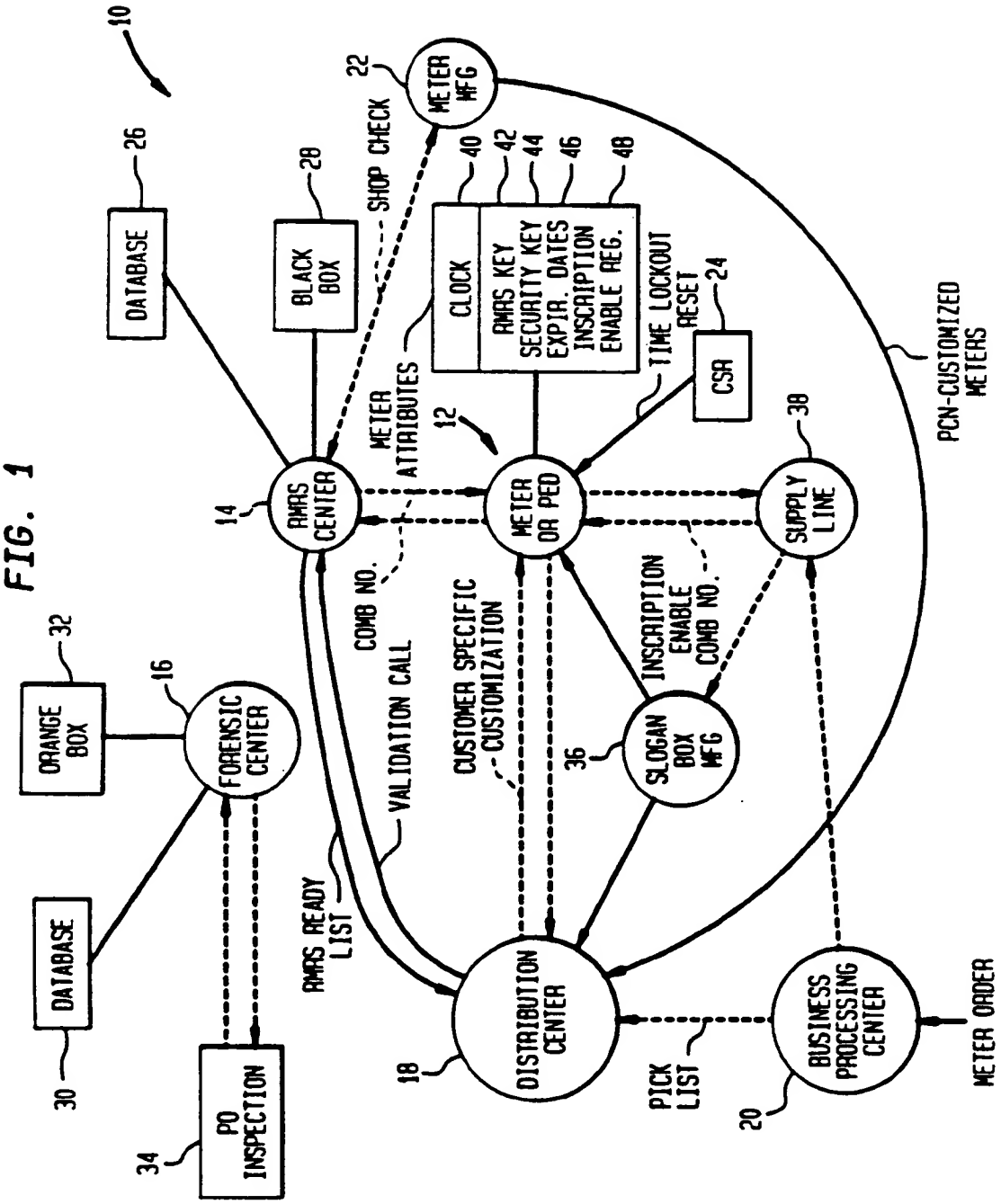
10
22
METER MFG
SHOP CHECK
26
DATABASE
28
BLACK BOX
40
42
44
46
48
CLOCK
RMAS KEY
SECURITY KEY
EXPIR. DATES
INSCRIPTION
ENABLE REG.
TIME LOCKOUT RESET
24
CSR
METER ATTRIBUTES
12
14
RMAS CENTER
METER OR PED
38
SUPPLY LINE
PCN-CUSTOMIZED METERS
COMB NO.
VALIDATION CALL
CUSTOMER SPECIFIC CUSTOMIZATION
INSCRIPTION ENABLE COMB NO.
32
ORANGE BOX
16
FORENSIC CENTER
36
SLOGAN BOX MFG
RMAS READY LIST
DATABASE
30
PO INSPECTION
34
18
DISTRIBUTION CENTER
PICK LIST
20
BUSINESS PROCESSING CENTER
METER ORDER

FIG. 1

FIG. 2A

PED ID	PS-DES POINTER	PS-DES (JULIAN DATE, POSTAGE, PIECE COUNT, PED ID)	VENDOR ECODE	ERROR DETECTION
1234567	89	01234567890123456789	012	2

FIG. 2B

PED ID	PS-DES (JULIAN DATE, POSTAGE, PIECE COUNT, PED ID)	VENDOR ECODE	ERROR DETECTION
1234567	01234567890123456789	012	9

FIG. 3A

PED ID	PS-DES POINTER	JULIAN DATE	POSTAGE	PIECE COUNT	PS ENCODE	VENDOR ECODE	ERROR DETECTION
1234567	89	01	.0290	678901	234	567	5

FIG. 3B

PED ID	JULIAN DATE	POSTAGE	PIECE COUNT	PS ECODE	VENDOR ECODE	ERROR DETECTION
1234567	01	.0290	678901	234	567	2

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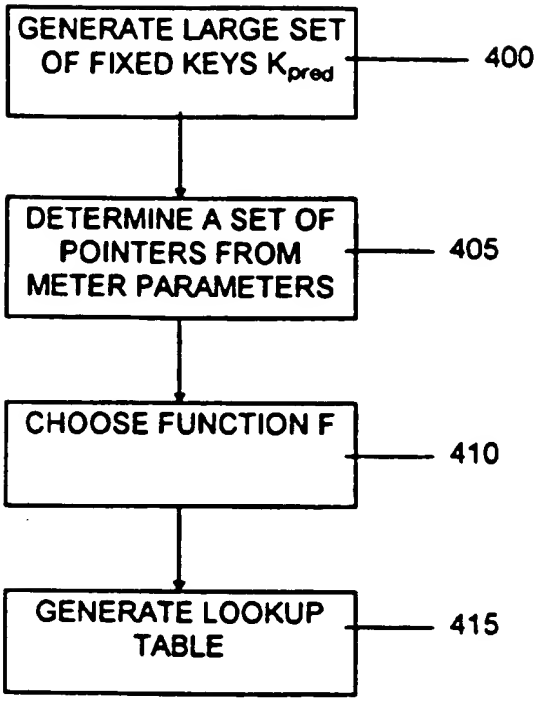

FIG. 4
KEY MANAGEMENT

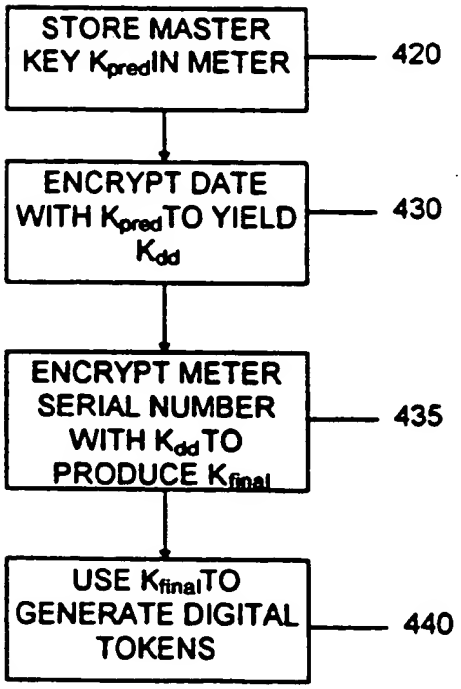

FIG. 5
METER OPERATION

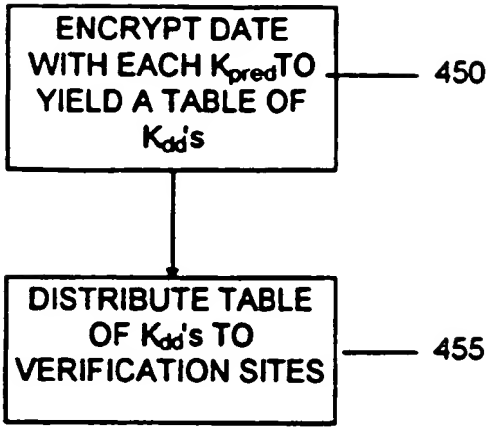

FIG. 7
DATA CENTER OPERATION

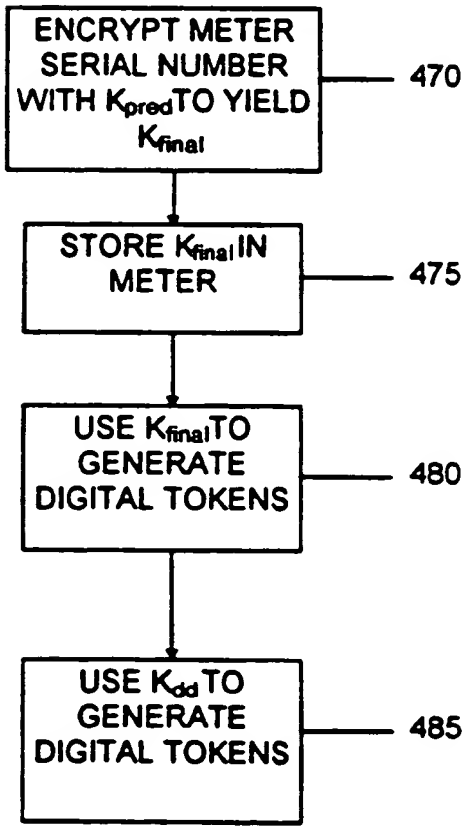

FIG. 6
ALTERNATE METER OPERATION

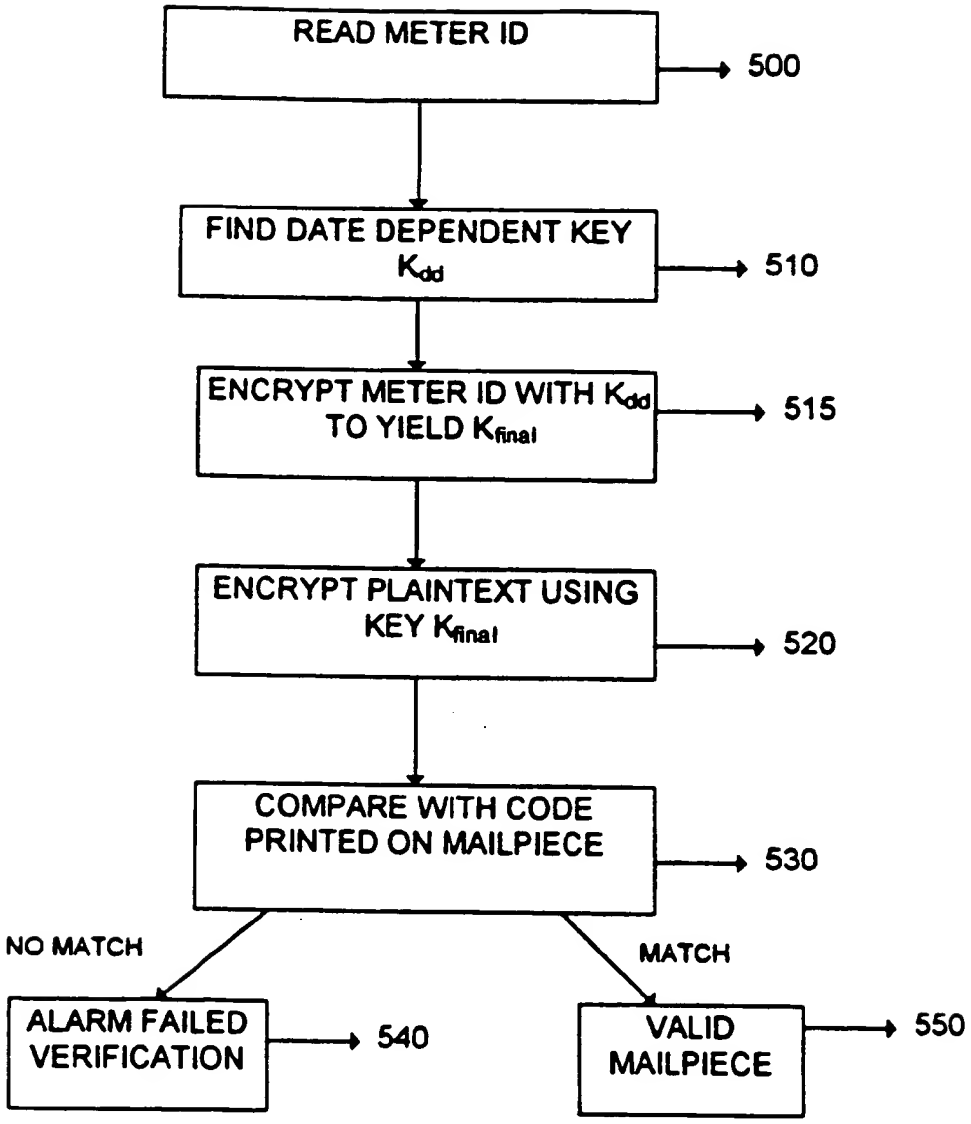

FIG. 8
VERIFICATION

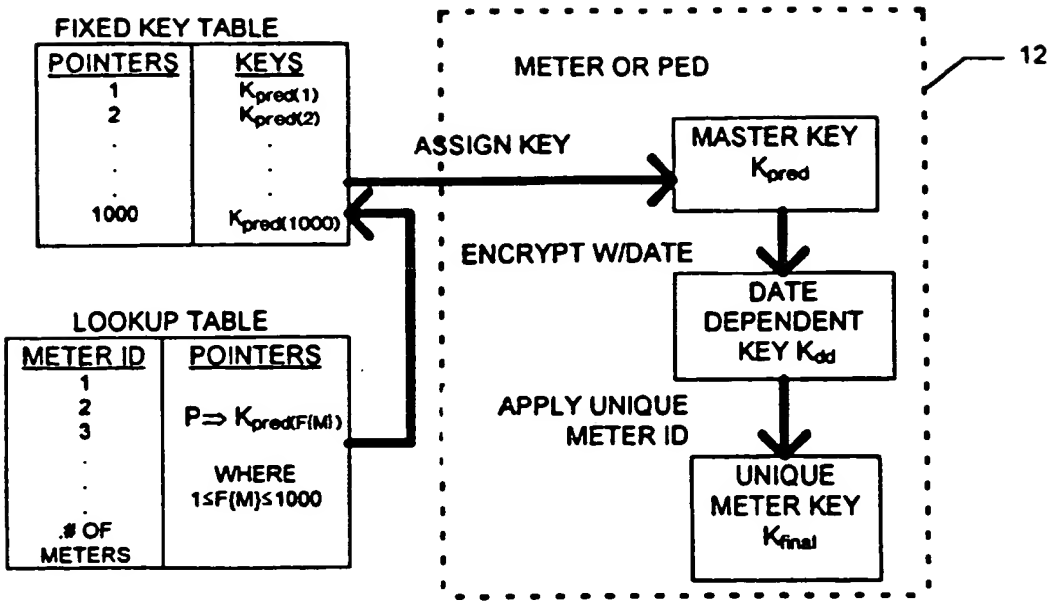
FIXED KEY TABLE
POINTERS
KEYS
1
2
1000
$K_{pred(1)}$
$K_{pred(2)}$
$K_{pred(1000)}$
METER OR PED
12
ASSIGN KEY
MASTER KEY
K_{pred}
ENCRYPT W/DATE
DATE DEPENDENT KEY K_{dd}
APPLY UNIQUE METER ID
UNIQUE METER KEY
K_{final}
LOOKUP TABLE
METER ID
POINTERS
1
2
3
.# OF METERS
$P \Rightarrow K_{pred(F(M))}$
WHERE 1≤F(M)≤1000

FIG. 9

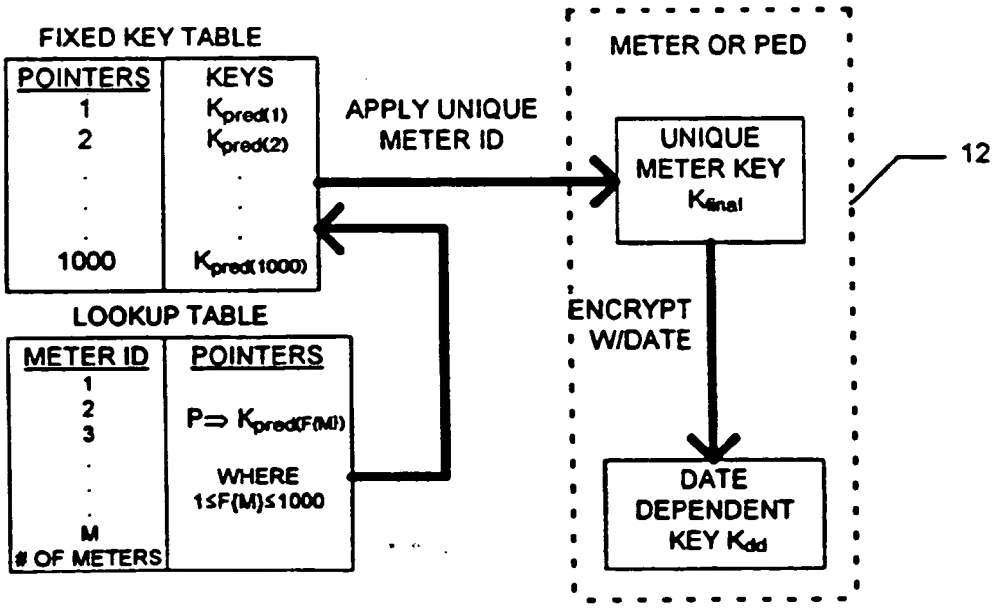
FIXED KEY TABLE
POINTERS
KEYS
1
2
1000
$K_{pred(1)}$
$K_{pred(2)}$
$K_{pred(1000)}$
APPLY UNIQUE METER ID
METER OR PED
UNIQUE METER KEY
K_{final}
12
ENCRYPT W/DATE
DATE DEPENDENT KEY K_{dd}
LOOKUP TABLE
METER ID
POINTERS
1
2
3
M
OF METERS
$P \Rightarrow K_{pred(F(M))}$
WHERE 1≤F(M)≤1000

FIG. 10

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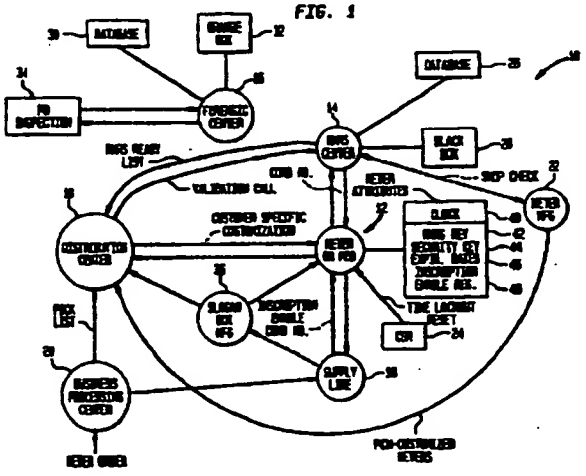
(54) Enhanced encryption control system for a mail processing system having data center verification

(57) A key control system comprises the generation of a first set of predetermined keys K_{pred} which are then used as master keys for a plurality of respective postage meters (12). The keys are then related to a respective meter (12) in accordance with a map or algorithm. The predetermined master key K_{pred} is encrypted with the date to yield a date dependent key K_{dd} related to the respective meter (12). The date dependent key is encrypted with a unique identifier or the respective meter to yield a unique key K_{final} that is by the respective meter to generate digital tokens. The Data Center (16) encrypts the date with each predetermined key K_{pred} to yield a table of dependent keys K_{dd}'s. The table of K_{dd}'s are distributed to verification sites. The verification site reads a meter's identification from a mailpiece being verified to obtain the dependent key K_{dd} of the meter (12). The verification side (34) encrypts the dependent key K_{dd} with the unique identifier to obtain the unique meter key which is used to verify tokens generated by the meter (12). In the preferred embodiment, the master key K_{pred}, the date dependent key K_{dd}, and the unique key K_{final}, in the meter are stored in the meter. In the alternate embodiment, the master key K_{pred} is encrypted with a unique meter identifier to obtain and the unique key K_{final} which is stored in the meter (12). The meter then generates its date dependent key K_{dd}, which is used to generate digital tokens.

FIG. 1



EP 0 840 258 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 11 9056

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 4 935 961 A (GARGIULO JOSEPH L ET AL) 19 June 1990 (1990-06-19) * claim 1; figure 3 *	1-10	G07B17/04 G07B17/02
A	EP 0 647 924 A (PITNEY BOWES) 12 April 1995 (1995-04-12) * claim 1; figure 1 *	1-10	
A	US 5 390 251 A (BROOKNER GEORGE M ET AL) 14 February 1995 (1995-02-14) * claim 1; figure 1 *	1-10	
A	EP 0 735 722 A (PITNEY BOWES) 2 October 1996 (1996-10-02) * claim 1; figure 7 *	1-10	
A	US 4 771 459 A (JANSEN CORNELIS J A) 13 September 1988 (1988-09-13) * claim 1; figure 4 *	1-10	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 March 2000	Kirsten, K

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 97 11 9056

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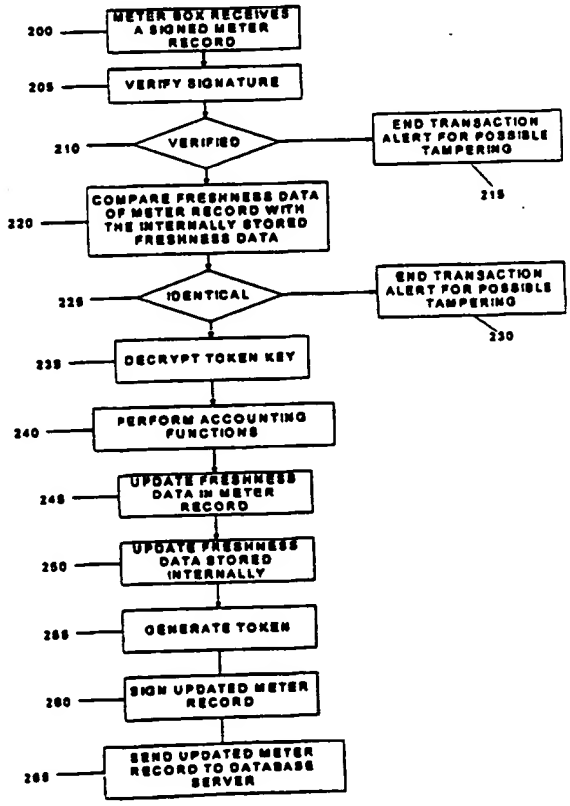
(54) Title: VIRTUAL POSTAGE METERING SYSTEM

(57) Abstract

A virtual postage metering system (10) and method provides value added services corresponding to postage metering transactions. Funds are not stored at the user's site reducing the risk of unauthorized modification of account balances. There is a database record (60) of every mail piece, which means that verification will be improved since all valid mail pieces are known. Furthermore, the present invention enables the postal service to know the volume of mail to be processed prior to receipt of the physical mail pieces. Since more mailer data is available (e.g. when users usually mail, how much mail per day, average postage amount) the virtual postage metering system (10) enables the postal service to predict mail handling patterns. Finally, users have the option to pay as they go (130) which contrasts present systems in which funds must be on deposit prior to being downloaded to a meter although such downloaded funds may remain in the meter for weeks before being used.



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VIRTUAL POSTAGE METERING SYSTEM

This is a continuation-in-part application of U.S. Provisional Patent Application Serial Number 60/049518, filed June 13, 1997 and assigned to the assignee of the present invention.

Field of the Invention

The present invention relates generally to a postage metering system and method for evidencing postage payment in an open system and, more particularly, to a postage metering system and method for evidencing postage payment in a virtual postage metering system 10 configuration.

Related Applications

The present application is related to the following International Patent Applications Serial Number (Attorney Docket Numbers E-733, E-734, E-735, E-736 and E-738), all filed concurrently herewith, all being assigned to the assignee of the present invention, all of which are incorporated herein by reference in their entirety.

Background of the Invention

Postage metering systems have been developed which employ encrypted information that is printed on a mailpiece as part of an indicium evidencing postage payment. The encrypted information includes a postage value for the mailpiece combined with other postal data that relate to the mailpiece and the postage meter printing the indicium. The encrypted information, typically referred to as a digital token or a digital signature, authenticates and protects the integrity of information, including the postage value, imprinted on the mailpiece for later verification of postage payment. Since the digital token incorporates encrypted information relating to the evidencing of postage payment, altering the printed information in an indicium is detectable by standard verification procedures. Examples of systems that generate and print such indicium are described in U.S. Patents Numbers 4,725,718, 4,757,537, 4,775,246 and 4,873,645, each assigned to the assignee of the present invention.

Presently, there are two postage metering device types: a closed system and an open system. In a closed system, the system functionality is solely

dedicated to metering activity. Examples of closed system metering devices, also referred to as postage evidencing devices, include conventional digital and analog (mechanical and electronic) postage meters wherein a dedicated printer is securely coupled to a metering or accounting function. In a closed system, typically the printer is securely coupled and dedicated to the meter, and printing evidence of postage cannot take place without accounting for the evidence of postage. In an open system, the printer is not dedicated to the metering activity, freeing system functionality for multiple and diverse uses in addition to the metering activity. Examples of open system metering devices include personal computer (PC) based devices with single/multi-tasking operating systems, multi-user applications and digital printers. An open system metering device is a postage evidencing device with a non-dedicated printer that is not securely coupled to a secure accounting module. An open system indicium printed by the non-dedicated printer is made secure by including addressee information in the encrypted evidence of postage printed on the mailpiece for subsequent verification. See U.S. Patents Numbers 4,725,718 and 4,831,555, each assigned to the assignee of the present invention.

The United States Postal Service ("USPS") has proposed an Information-Based Indicia Program ("IBIP"), which is a distributed trusted system to retrofit and augment existing postage meters using new evidence of postage payment known as information-based indicia. The program relies on digital signature techniques to produce for each envelope an indicium whose origin can be authenticated and content cannot be modified. IBIP is expected to support new methods of applying postage in addition to the current approach, which typically relies on a postage meter to print indicia on mailpieces. IBIP requires printing a large, high density, two-dimensional ("2-D") bar code on a mailpiece. The 2-D bar code encodes information and is signed with a digital signature.

The USPS has published draft specifications for IBIP. The INFORMATION BASED INDICIA PROGRAM (IBIP) INDICIUM SPECIFICATION, dated June 13, 1996, and revised July 23, 1997, ("IBIP Indicium Specification") defines the proposed requirements for a new indicium that will be applied to mail being created using IBIP. The INFORMATION BASED INDICIA PROGRAM POSTAL SECURITY DEVICE SPECIFICATION,

dated June 13, 1996, and revised July 23, 1997, ("IBIP PSD Specification") defines the proposed requirements for a Postal Security Device ("PSD"), which is a secure processor-based accounting device that dispenses and accounts for postal value stored therein to support the creation of a new "information based" postage postmark or indicium that will be applied to mail being processed using IBIP. The INFORMATION BASED INDICIA PROGRAM HOST SYSTEM SPECIFICATION, dated October 9, 1996, defines the proposed requirements for a host system element of IBIP ("IBIP Host Specification"). IBIP includes interfacing user, postal and vendor infrastructures which are the system elements of the program. The INFORMATION BASED INDICIA PROGRAM KEY MANAGEMENT PLAN SPECIFICATION, dated April 25, 1997, defines the generation, distribution, use and replacement of the cryptographic keys used by the USPS product/service provider and PSDs ("IBIP KMS Specification"). The specifications are collectively referred to herein as the "IBIP Specifications".

The IBIP Specifications define a stand-alone open metering system, referred to herein as a PC Meter comprising a PSD coupled to a personal computer ("PC") which operates as a host system with a printer coupled thereto ("Host PC"). The Host PC runs the metering application software and associated libraries (collectively referred to herein as "Host Applications") and communicates with one or more attached PSDs. The PC Meter can only access PSDs coupled to the Host PC. There is no remote PSD access for the PC Meter.

The PC Meter processes transactions for dispensing postage, registration and refill on the Host PC. Processing is performed locally between the Host PC and the PSD coupled thereto. Connections to a Data Center, for example for registration and refill transactions, are made locally from the Host PC through a local or network modem/internet connection. Accounting for debits and credits to the PSD is also performed locally, logging the transactions on the Host PC. The Host PC may accommodate more than one PSD, for example supporting one PSD per serial port. Several application programs running on the Host PC, such as a word processor or an envelope designer, may access the Host Applications.

The IBIP Specifications do not address an IBIP open metering system on a network environment. However, the specifications do not prohibit such a

network-based system. Generally, in a network environment a network Server controls remote printing requested by a Client PC on the network. Of course, the Client PC controls any local printing.

One version of a network metering system, referred to herein as a "virtual postage metering system 10", has many Host PCs without any PSDs coupled thereto. The Host PCs run Host Applications, but all PSD functions are performed on Server(s) located at a Data Center. The PSD functions at the Data Center may be performed in a secure device attached to a computer at the Data Center, or may be performed in the Data Center computer itself. The Host PCs must connect with the Data Center to process transactions such as postage dispensing, meter registration, or meter refills. Transactions are requested by the Host PC and sent to the Data Center for remote processing. The transactions are processed centrally at the Data Center and the results are returned to the Host PC. Accounting for funds and transaction processing are centralized at the Data Center. See, for example, U.S. Patents Numbers 5,454,038 and 4,873,645, which are assigned to the assignee of the present invention.

The virtual postage metering system 10 does not conform to all the current requirements of the IBIP Specifications. In particular, the IBIP Specifications do not permit PSD functions to be performed at the Data Center. However, it is understood that a virtual postage metering system 10 configuration with each mailer's PSD located at the Data Center may provide an equivalent level of security as required by the IBIP Specifications.

In conventional closed system mechanical and electronic postage meters a secure link is required between printing and accounting functions. For postage meters configured with printing and accounting functions performed in a single, secure box, the integrity of the secure box is monitored by periodic inspections of the meters. More recently, digital printing postage meters typically include a digital printer coupled to a metering (accounting) device, which is referred to herein as a postal security device (PSD). Digital printing postage meters have removed the need for physical inspection by cryptographically securing the link between the accounting and printing mechanisms. In essence, new digital printing postage meters create a secure point to point communication link

between the PSD and print head. See, for example, U.S. Patent Number 4,802,218, issued to Christopher B. Wright et al. and now assigned to the assignee of the present invention. An example of a digital printing postage meter with secure print head communication is the Personal Post Office™ manufactured by Pitney Bowes Inc. of Stamford, Connecticut.

In U.S. Patents Number 4,873,645 and 5,454,3,038, a virtual postage metering system and method are disclosed wherein the postal accounting and token generation occur at a data center remote from the postage evidencing printer. Although the Data Center may be a secure facility, there remain certain inherent security issues since the accounting and token generation functions do not occur in a secure device local to the postage printer. The virtual postage metering system includes a computer coupled to an unsecured printer and to a remote data metering system. The postal accounting and the token generation occur at the Data Center.

The Data Center is a centralized facility under the control of a meter vendor, such as Pitney Bowes, or the Postal Service. As such, it is regarded as secure compared to the environment that mailers handle meters directly. However, data stored at the Data Center is accessible to Data Center personnel and, therefore, at a minimum, subject to at least inadvertent modification by such personnel. Any unauthorized changes to the user and meter data stored at the Data Center compromises the integrity of the virtual postage metering system.

Summary of the Invention

It has been determined that a virtual postage metering system provides benefits that are not available under conventional postage payment systems. For the Posts, a virtual postage metering system provides central management of all postage without the need to manage physical meters or PSDs. A further benefit is the opportunity to directly associate a mailer to each mailpiece as opposed to each reset. For mailers, no metering hardware, i.e. postage meter or PSD, is needed. Nor do mailers need to maintain current lists of valid addresses, such as with purchased CD-ROMs. Mailers can acquire postage on an as-needed basis. Finally, meter vendors do not have to keep track of

physical meters. A virtual postage metering system eliminates stolen or relocated meter problems and simplifies meter management in general.

The virtual postage metering system is configured with a local PC obtaining postage value from a PSD that is remotely located at the Data Center. The PC includes a modem or internet connection for accessing the Data Center.

In accordance with the present invention, a virtual postage metering system and method provides value added services corresponding to postage metering transactions. Funds are not are stored at a user's site reducing the risk of unauthorized modification of accounting balances. There is a database record of every mailpiece, which means that verification will be improved since all valid pieces are known. Furthermore, the present invention enables the Post to know the volume of mail to be processed prior to receipt of physical mail pieces. Since more mailer data is available (e.g. when users usually mail, how much mail per day, average postage amount) the virtual postage metering system enables the postal service to predict mail handling patterns. Finally, users have the option to pay as they go which contrasts present systems in which funds must be on deposit prior to being downloaded to a meter although such downloaded funds may remain in the meter for weeks before being used.

Description of the Drawings

The above and other objects and advantages of the present invention will be apparent upon consideration of the following detailed description, taken in conjunction with accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

Fig. 1 is a block diagram of a virtual postage metering system for dispensing postage embodying the principles of the present invention;

Fig. 2 is a bock diagram of the Data Center database server and secure box for the virtual postage metering system of Fig. 1;

Fig. 3 is a process flow for postage authorization and printing by a postage metering system;

Fig. 4 is a flow chart of the process for evidencing postage by the virtual postage metering system of Fig. 1;

Fig. 5 is a flow chart of the process performed within the secure meter box of the virtual postage metering system of Fig. 1;

Fig. 6 is a flow chart of the process for trickle charge method for accounting and distributing funds to multiple origins of deposit in accordance with the present invention; and

Fig 7 is a flow chart of a prepayment method for accounting and distributing funds to multiple origins of deposit.

Detailed Description of the Present Invention

In describing the present invention, reference is made to the drawings, wherein there is seen in Fig. 1, a virtual postage metering system, generally designated 10. Virtual postage metering system 10 prints open system indicia for securely evidencing postage. Virtual postage metering system 10 includes a plurality (only one is shown) of personal computer (PC) systems, generally designated 20, each having access to a printer 22 for printing evidence of postage on an envelope or label. PC 20 is connected with a transaction processing Data Center 30 that performs postal accounting and evidencing of postage. The virtual postage metering system 10 allows each mailer to use a conventional PC to remotely obtain evidence of postage payment on an as needed basis. Unlike conventional postage metering systems, virtual postage metering system 10 does not include any meter hardware located at the mailer's site. Nor are any postal funds stored at the mailer's site. All metering and accounting of funds occur at Data Center 30 using functional software and database records representing each mailer's "postage meter", referred to herein as a "meter account".

The accounting method for virtual postage metering system 10 may be a conventional prepayment or post-payment system. The preferred method a prepayment method wherein each mailer is required to put a minimum amount of money into the mailer's virtual postage metering system 10 account. As account funds drop below a specific level a refill is charged against the mailer's account. An alternate accounting method that is suitable for a virtual postage metering system is a real-time payment method in which the amount of a transaction is charged to a mailer's credit card account when the transaction occurs. This

method is referred to herein as a "trickle charge" postage payment, because the mailer does not pay for postage for a mailpiece until the mailer is ready to print the mailpiece.

In the virtual postage metering system, a "meter" vendor, such as Pitney Bowes Inc., provides the mailer with client software that runs on PC 20, e.g., the client software may be downloaded from the vendor's Internet server. Alternatively, the client software may be the Internet browser based home pages that provide user interactions with the Data Center 30. The meter vendor also manages Data Center 30. The client software initiates communications with Data Center 30 which performs metering transactions to evidence postage for single mailpieces or batches of mailpieces. In the preferred embodiment, the client software establishes a connection to the Data Center, and requests postage by providing postal information relating to the requested transactions, such as postage amount, addressee information and (optionally) the origin of deposit for each mailpiece. Data Center 30 receives the postal information, determines the origin zip for the mailpiece(s), performs accounting functions and generates an encrypted evidence of postage payment, such as a token or digital signature, and sends indicium information including the token, to PC 20. PC 20 receives the indicium information, creates an indicium bitmap, which can be displayed on a PC monitor (not shown) and printed on the mailpiece by printer 22. PC 20 then disconnects from Data Center 30 or requests another transaction. The connection between PC 20 and Data Center 30 may be through a Network Service Provider, such as on the Internet, or by direct dial using the PC's modem.

Virtual postage metering system 10 eliminates the need to maintain and account for traditional metering devices at each mailer's site and provides flexibility for handling requests from multiple origins of deposit by each mailer. Virtual postage metering system 10 also provides value added services that are not available with conventional meter devices, such as, real-time address hygiene, direct marketing services and trickle charge postage payment. Virtual postage metering system 10 provides user authentication by Data Center 30 to identify mailers with valid accounts. When a mailer has been authenticated for each request, for example, by a username, password or other conventional

methods, Data Center 30 services the request, and returns indicium information to the PC 20 where the indicium is created and printed on the mailpiece.

Referring again to Fig. 1, the mailer initiates a postage evidencing transaction by running client software in PC 20, which contacts Data Center 30. At Data Center 30, a Communication Server 32 supports connectivity from various communication technologies and protocols. The Communication Server merges all incoming traffic and routes it to a Function Server 34, which includes application software that supports mailer sign-on, postage dispensing and postal reporting. All mailer and meter information is accessed from a Database Server 36 where the information is securely stored using secure cryptographic processes and protocols as described below. Data Center 30 maintains cryptographic keys for each meter account in Database Server 36. The cryptographic keys are used for postage evidencing and verification as well as for security of the records stored in Database Server 36. A Key Management System 38 administers all cryptographic keys used in virtual postage metering system 10. The cryptographic keys may be distributed to verifiers in remote locations. U.S. Patent Application Serial Number 08/553812, filed October 23, 1995, and assigned to the assignee of the present invention, describes such a key management system.

A mailer may establish a meter account through an on-line sign-up process with Data Center 30. During sign-up, the mailer enters, at PC 20, account information, such as user name, password and method of payment. Any registration fees can be charged at this time. Data Center 30, preferably administered by a meter vendor, such as Pitney Bowes Inc., arranges all meter licenses and agreements between its mailers and the Post.

In the present invention, the PSD does not exist, i.e., there is no metering device coupled to the PC from which postage payment is requested. Virtual postage metering system 10 replaces the accounting and metering functions of the PSD with metering software at PC 20 and mailer account information performed and updated at Data Center 30. The virtual postage metering system 10 provides each mailer with a metering system that has the capability of originating transactions from multiple origins of deposit. See, for example,

previously noted International. Patent Application Serial Number [Attorney Docket E-735].

Various methods can be used to determine the origin of deposit for a requested transaction. For example, a method for determining origin zip code using a caller ID from a telephone call is disclosed in U.S. Patent Application Serial Number 08/775,818, filed December 31, 1996, and assigned to the assignee of the present invention, which is hereby incorporated in its entirety by reference.

In accordance with the present invention, one or more cryptographic modules, referred to herein as secure "boxes", are located within Data Center 30 and are used to perform cryptographic processes. Each secure box is a secure, tamper-evident and tamper-responding device, including a processor and memory, that stores encryption keys and performs cryptographic operations using the keys within the secure boundary of the device. Data Center 30 includes several types of secure boxes, which are described below. In the preferred embodiment, Data Center 30 includes multiple boxes of each type for redundancy and performance.

Key Management System 38 includes a manufacturing box (not shown) that provides top-level keys used to generate random numbers for seeding each of the other secure boxes. By sharing a common cryptographic key, the secure boxes communicate securely within Data Center 30. Key Management System 38 also includes a "steel" box (not shown) that shares a common key with meter box 44 (described below) to encrypt/decrypt master token keys for postage evidencing transactions for each meter account. The steel box merges a vendor key and a postal key into one record in cipher text. For each meter account, Data Center 30 creates a logical meter, i.e. a meter record, in Database Server 36 by generating a token key using the vendor and postal keys, initializing meter registers (ascending and descending), meter freshness data (described below) and other postal information as part of the meter record, and then storing the meter record in Database Server 36.

Data Center 30 also includes a meter box 44 that shares a secret key with the steel box for decrypting the token key encrypted in the meter record. Meter box 44 also holds the key used for digital signature of transaction records, which

are stored in Database Server 36. The only other information stored in meter box 44 is freshness data for each meter record processed by meter box 44. For each postage transaction, meter box 44 generates at least one digital token or signs the postage transaction, and updates the meter record corresponding to the transaction. Each meter record in Database Server 36 includes postal funds as well as the token keys in cipher text. Meter box 44 uses the token keys to generate tokens, updates the postal funds in the meter record, and signs the updated meter record. In this manner, meter box 44 performs and controls the secure accounting for each transaction. Meter box 44 can also be used to verify the token or the transaction signature for verification of the postage evidencing for the transaction.

Data Center 30 also includes an authentication box 40 that shares a different secret key with the steel box to decrypt an user authentication key stored in cipher text in Database Server 36. Authentication box 40 also executes the authentication algorithms using the decrypted authentication key to authenticate a mailer. This function may be added to the steel box of key management system 38 to eliminate the need for a separate box at Data Center 30.

Finally, Data Center 30 includes an transaction box 42 that shares another secret key with the steel box to sign user transaction records other than the meter records signed by meter box 44, such as logins and login history records. Transaction box 42 later verifies the transaction record signature when the next transaction is requested.

Referring now to Fig. 2, a configuration of Database Server 36, including a meter database 60, a mailer database 62 and a database of meter records 64, is shown. Meter database 60 comprises meter information associated for each meter account, such as, meter serial number, record update counter, ascending register, descending register and other postal values. Meter Database 60 also includes storage of transaction records signed by meter box 44. The transaction records comprise, for example, origin postal code, transaction date/time, indicium date, delivery postal code, token(s), postage amount, and the digital signature. Mailer database 62 comprises mailer information and information that associates a mailer with a meter account.

In operation, Communication Server 32 receives a request for a meter transaction from mailer PC 20. The application software in the Function Server 34 controls the processing of the transaction request. Function Server 34 accesses mailer database 62 and meter database 60 to obtain records, including the appropriate meter record 64, corresponding to the meter account of the mailer initiating the request. Function Server 34 communicates mailer records from mailer database 62 to authentication box 40, which then authenticates the mailer requesting the transaction. Once the mailer has been authenticated, Function Server 34 communicates the appropriate meter record 64 to meter box 44, which verifies a signature and freshness data for the record. Meter box 44 decrypts the encrypted key(s) that are stored within meter record 64, performs accounting functions on the ascending and descending registers in meter record 64, and uses the key(s) to generate a token for the requested transaction. Meter box 44 then generates data for an indicium, and resigns meter record 64. The updated and signed record is then sent back to Database Server 36 where it is stored as part of meter database 60.

At Data Center 30,the authentication keys are not available in plain text, but must be distributed to the mailer. Conventional methods of distributing and updating the authentication key for each mailer can be used. See, for example, previously noted U.S. Patent Application Serial Number 08/553812, which describes a key management system for distributing and updating cryptographic keys to the secure boxes and the mailer's PC.

One of the important tasks for key management system 38 is to obtain the postal key and associate it with a vendor key. In key management system 38, the steel box creates a meter serial number, manufacturing number, vendor and postal keys in one meter record 64 for each meter account.

For the encryption/decryption algorithms, a set of triple DES keys are used for encrypting the encryption keys for generating a tokens or signatures for indicia. Another set of triple DES keys are used for signing meter records. Meter box 44 securely stores both sets of triple DES keys. In order avoid using only one key to encrypt the entire set of meter keys for generating a tokens or signatures for indicia, a derived key is used. The first set of triple DES keys derives triple DES keys by encrypting the meter (account) serial number in each

meter record. The derived triple DES keys then encrypt the encryption keys for the indicia which are to be stored in the Database Server 36. The second set of triple DES keys for signing uses a similar scheme to derive the signature keys in a similar manner, i.e. using the meter serial number as data to derive keys. It will be understood that one set of triple DES keys can be used for both purposes. However, it is desirable that each set of keys be used only for one purpose.

In the preferred embodiment of the present invention, one common key is used to sign all transactions and records that require a digital signature, such as, meter records, postage transactions, funds transfer records, master account records, etc. Multiple boxes of each box are used for redundancy and to share the workload as the number of transactions grow. The signing box, such as meter box 44 or authentication box 40, will also verify the signature of a record.

With regard to the signature algorithm for meter record 64, a message authentication code (MAC) is employed to provide message integrity for the sensitive virtual postage metering system 10 records. This MAC involves multiple applications of the Data Encryption Standard (DES). The signature keys will be updated using the current month and year. During manufacturing, two initial master keys will be entered into the non-volatile memory (NVM) of meter box 44. NVM is used both for permanent storage and for the prevention of external access to the key information. The keys for indicia and the keys for signature are derived in a conventional manner, such as described above. The virtual postage metering system 10 record signature verification algorithm simply recalculates the signature of the meter record 64 using the signature algorithm and data within meter record 64 and compares calculated signature to the signature in meter record 64.

Referring now to Fig. 3, a typical process flow for postage authorization and printing is shown. The process includes operations occurring in four modules in a postage metering system: a mail generator module 80, a rating module 82, an accounting module 84 and an encryption module 86. The mail generator module 80 includes a list of addresses and a list of postal rate parameters. The rating module 82 includes the current rate table and a rate table signature which authenticates the current rate table. The accounting

module 84 includes an ascending register (AR), a descending register (DR) and a piece count. The encryption module 86 includes cryptographic keys, origin ZIP information and an identification of the postage metering system (meter ID).

In virtual postage metering system 10, mail generator module 80 resides in PC 20 and the rating, accounting and encryption modules reside at Data Center 30. The encryption module 86 resides in meter box 44, and the accounting module 84 resides in part in meter box 44 (AR, DR and piece count) and in Database Server 36 (accounting functions). The rating module 82 preferably resides in Database Server 36, however, the rating module may reside in PC 20. In a PC metering system, the accounting and encryption modules would reside in the PSD and the mail generator and rating modules would reside in the Host PC.

The following process is described for a postage evidencing transaction for a single mailpiece. It will be understood that the process may also be used for postage evidencing transactions for a batch of mailpieces.

The process begins with mail generator module 80 initiating a request for postage. Prior to this request for postage, a user has selected (for each mailpiece) a mailing address from the address list and entered or defaulted to various rate parameters for a mailpiece. The rating module 82 receives the request with the rate parameters, calculates postage amount and requests postage evidencing. It is noted that the user may enter a postage amount, which could be one of the rate parameters in which case, the rating module would defer to the entered postage amount. The accounting module 84 approves the request for postage evidencing, subtracts the postage amount from the descending register, adds the postage amount to the ascending register and increments the piece count. Once the accounting has been completed, the encryption process is enabled. The encryption module 86 performs the encryption function using the postal and vendor keys, origin ZIP received from mail generator module), meter ID, AR and DR and piece count (collectively referred to as postal data). The encryption function, which is a cryptographic transformation computation that utilizes, for example, a secret key to produce digital tokens/signatures, provides one or more digital tokens or digital signatures of the previously noted postal data. The postal data and digital tokens/signatures are

collectively referred to herein as indicium data. The mail generator receives the indicium data, optionally verifies that sufficient postage has been paid and prints the indicium.

Referring now to Fig. 4, the process for securely performing a postage evidencing transaction in a virtual postage metering system is described. At step 100, Communication Server 32 receives a request for postage evidencing from mailer PC 20. At step 105, Function Server 34 requests access to the mailers account information stored in Database Server 36. At step 110, Database Server 36 sends mailer information, meter information, including a meter record associated with the mailer initiating the request. At step 115, Function Server 34 sends the mailer information to Authentication Box 40. When the mailer is authenticated at step 120, then, at step 125, Function Server 34 sends the meter information, including the meter record to meter box 44. At step 130, meter box 44 authenticates the meter record, decrypts the encrypted token key which is part of the record, verifies freshness of the record, performs accounting, generates a token, updates the freshness data and signs the meter record, which is returned to Function Server 34. At step 135, Function Server 34 sends the updated and signed meter record to Database Server 36 and sends to the Communication Server 32 the token and associated postal information needed to create an indicium. At step 140, Database Server 36 stores the updated and signed meter record. At step 145, Communication Server 32 sends the token and postal information to mailer PC 20.

Referring now to Fig. 5, the process performed within the secure meter box of the virtual postage metering system is described. At step 200, meter box 44 receives a signed meter record. At step 205, the signature of the meter record is verified. If not verified at step 210, then, at step 215, the meter box ends the transaction and alerts the Function Server 34 for possible tampering. If the signature has been verified, then, at step 220, the meter box compares freshness data that is stored in meter box for each meter account to freshness data stored as part of the meter record. The freshness data chosen for this comparison must be data that is unique for each transaction. In the preferred embodiment, the record update counter is used, however a random number, time stamp or other nonce may be used. The comparison at step 220 prevents

inadvertent or intentional substitution of an old meter record for the current meter record during the virtual postage metering transaction.

At step 225, if the compared freshness data are not identical, then, at step 230, the meter box ends the transaction and alerts the Function Server 34 for possible tampering. If the freshness data stored in the meter record is identical to the freshness data associated with the meter record which is stored in the meter box, then, at step 235, the meter box decrypts the token key that was received in encrypted form as part of the meter record. At step 240, the meter box performs accounting functions for the transaction, such as incrementing the ascending register, decrementing the descending register and incrementing the record update counter. At step 245, the freshness data in the meter record is updated. At step 250, the freshness data stored in meter box 44 is updated. At step 255, the meter box generates the token using the decrypted token key. At step 260, the meter box updates the meter record by storing the new register values and record update counter in the meter record, and then signs the updated record using a key stored in the meter box. At step 265, the meter box sends the updated and signed meter record to Database Server 36 for storage until the next transaction for the meter account assigned to the meter record.

Referring now to Fig. 6, the process for distributing funds in accordance with a trickle charge method of payment begins at step 300, with the mailer, through PC 20, authorizing use of a credit card account to a funds control center, such as a bank. (Such authorization may occur through the Data Center to the funds control center.) At step 305, the funds control center acknowledges such authorization and notifies Data Center 30. At step 310, the Data Center activates the mailer's PSA by assigning the mailer's credit card account to it and notifies the mailer. At step 315, the mailer, through PC 20, initiates a request for indicium information from the Data Center 30, providing postal information, such as, postage amount and destination information. At step 320, Data Center 30 responds to the request by verifying sufficient funds are available, charging the mailer's credit card account, determining valid origin zip for the request, calculating a digital token or digital signature corresponding to the postal information provided with the request, and forwarding the indicium information including the digital token to PC 20. Data Center 30 also stores information

relating to each transaction as a historical record to be forwarded to the Postal Service at a predetermined interval. At step 325, PC 20 obtains the indicium information from Data Center 30, generates an indicium bitmap and prints the indicium on the mailpiece. At some predetermined interval, for example daily, at step 330, Data Center 30 notifies the Postal Service of the total postage amount for each meter ID (PSA) and origin zip combination by forwarding the historical record to the Postal Service. At step 335, the Postal Service combines the transactions for each origin zip to determine the amount owed to each origin zip (local) post office. At step 340, the Postal Service assigns an appropriate amount of funds from the funds control center to each local post office. Alternatively, steps 335 and 340 could be performed at the Data Center or funds control center.)

Referring now to Fig. 7, the process for distributing funds in accordance with a prepayment version of the present invention begins at step 400, with the mailer, through PC 20, sending funds to a funds control center, such as a bank. At step 405, the funds control center acknowledges such authorization and notifies Data Center 30. At step 410, the Data Center adjusts the PSA for the mailer to account for the additional funds and notifies the mailer. At step 415, the mailer, through PC 20, initiates a request for indicium information from the Data Center 30, providing postal information, such as, postage amount and destination information. At step 420, Data Center 30 responds to the request by verifying sufficient funds are available, debiting the mailer's account, determining valid origin zip for the request, calculating a digital token or digital signature corresponding to the postal information provided with the request, and forwarding the indicium information including the digital token to PC 20. Data Center 30 also stores information relating to each transaction as a historical record to be forwarded to the Postal Service at a predetermined interval. At step 425, PC 20 obtains the indicium information from Data Center 30, generates an indicium bitmap and prints the indicium on the mailpiece. At some predetermined interval, for example daily, at step 430, Data Center 30 notifies the Postal Service of the total postage amount for each meter ID (PSA) and origin zip combination by forwarding the historical record to the Postal Service. At step 435, the Postal Service combines the transactions for each origin zip to

determine the amount owed to each origin zip (local) post office. At step 440, the Postal Service assigns an appropriate amount of funds from the funds control center to each local post office.

Function Server 34 performs the following process for user sign-up. Function Server 34 validates received sign-up information received from PC 20. Accessing Database Server 36, Function Server 34 obtains the next available master account ID number and the next available customer ID number from the database. Function Server 34 then creates a new master account record and, in conjunction with Key Management System Server 38, generates keys for the new meter account. Function Server 34 server transfers funds from the newly created master account to the new meter account. Function Server 34 creates a new meter record 64 which is stored in meter database 60 in Database Server 36 and a new mailer record which is stored in mailer database 62 in Database Server 36.

During sign up of new mailers, the mailer's address information is entered at PC 20. The Virtual postage metering system 10 client software running in PC 20 selects the zip code from the address information entered by a user. The zip code is checked to be a valid zip code and is assigned as the origin of deposit for the user's account. The signup request is transmitted to the Data Center 30. Function Server 34 receives the request for a new mailer account and processes the request as set forth above to establish a new meter record 64. The meter record 64 is then associated with the origin of deposit from the signup request, which becomes the default origin of deposit for meter record 64.

Function Server 34 performs the following process when a request for a postage transaction is received from PC 20. Function Server 34 checks the validity of the postal data, such as date of mailing, amount of postage, origin postal code and destination address, that is received with the request. If not valid, Function Server 34 exits the process. If valid, Function Server 34 communicates with Database Server 36 to retrieve the meter record 64 corresponding to the user initiating the request. Function Server 34 verifies sufficient funds are available in the user's account for the requested transaction. If sufficient funds are available, Function Server 34 sends the meter record and the postal data to meter box 44 which performs the process set forth above.

When meter box completes the accounting process, Function Server 34 constructs the postage transaction record reflecting the completed transaction, signs it and sends it to Database Server 36 for storage. Function Server 34 also sends the updated meter record 64 that is receives from meter box 44 to Database Server 36 for storage.

Database Server 36 includes records of mail volumes and accounting of postal funds within it database. By access Data Center 30, the postal service can perform on-line tracking of selected information available from Data Center 3. Such information includes volumes of mail pieces processed or in process, allocation of funds to originating post offices and meter account use. Such on-line tracking allows the postal service to manage it resources in a more efficient manner. For example, the postal service could identify locations with peak workloads and could determine locations of mail fraud by comparing mail volumes with expected postal revenues.

Fundamental to virtual postage metering system 10 is the information that is available within the files and records stored in Database Server 36. As described above, Data Center 30 provides typical metering related administrative services, such as evidencing postage, creating user accounts, authenticating users, registering new meter accounts, activating and deactivating meter accounts, managing postage funds, and logging transactions and meter usage. Data Center 30 provides reports on postage transactions and meter usage to the user, to the administrator, such as Pitney Bowes Inc., and to the postal service. The reports can be organized by user account (and user's departmental accounts), indicia serial number, and/or origination zip, as requested.

Data Center 30 has the capability of handling simultaneous execution of multiple transaction types, such as on-line and deferred transaction execution. Data Center 30 provides reception, queuing and execution of multiple requests/services concurrently.

Data Center 30 "manufactures" meters, i.e. metering accounts, registers meters; licenses meters, activates valid meters, and deactivates invalid meters from normal operation (i.e. out of service meters). The manufacturing of a meter entails associating the manufacturing number with the meter keys (such as postal key and the vendor key). The keys are securely installed and verified.

Function Server 34 interfaces with the Key Management System Server 38 for installing keys, verifying keys, and registering meters. Meters are activated by assigning one or more users the privilege of using the metering account. The meter is associated with a meter record that includes an indicia serial number, manufacturing number, postal key, vendor key and piece count.

The meter (i.e. indicia serial number) is associated with an origin postal code (e.g., origination zip code) to accommodate postal deposit restrictions and accounting of postal funds. Data Center 30 registers meters for the postal service by associating an indicia serial number with an origination zip code, and filing the appropriate postal forms. If the meter has an origin postal code of "00000", the user shall be able to select the origin of deposit. A floating origin of deposit, "00000", allows customers to use their on-line meters from a variety of locations.

Data Center 30 creates, deletes, modifies and authenticates users. Data Center 30 sets up and modifies access rights for the users to request transactions, purchase postage, and receive administrative services. Meters may be deactivated from normal operation temporarily or permanently, due to insufficient funds, inspection, credit abuses or meter abuses.

Value-Added Services

Virtual postage metering system 10 provides value-added services for the user and the postal service. Data Center 30 allows the user access to user account information, on-line rates, special mail services, address cleansing and postal coding services. Data Center 30 shall allows the Post access to postal revenue accounting (postage used by origin postal codes) and to transfer files containing address changes. The user may request accounting services by master account, department, meter and user.

Data Center 30 provides the ability to cleanse an address (i.e. make corrections to invalid addresses) and attach postal coding. See, for example, U.S. Patent Number 5,454,038. Data Center 30 provides domestic and international postal rates. PC 20 can be integrated with a scale for input into the postal rating process. Data Center 30 provides on-line services such as certified mail and special receipts. Data Center 30 provides on-line tracking of postal funds and mail volumes to authorized postal employees.

Data Center 30 provides a change of address service to the users. The data center shall provide mechanism to accept a list of addresses from the post and manage the list. Addresses accepted from the user are checked against the list from the post to determine if any of the addresses have changed. The data center shall notify the user of addresses that have changed.

Virtual postage metering system 10 includes load balancing capability which Data Center 30 to process requests from all remote users in a timely and efficient manner. Load balancing as applied to Virtual postage metering system 10 ensures that each new request for service is directed to the least used resource in a system where there are multiple resources providing the same service. This applies to VM resources like Communication Server 32, Functional Server 34, Database Server 36, Key Management System Server 38 and the secure boxes in Data Center 30.

Virtual postage metering system 10 includes communication architecture that understands where the application services are located and the number of users connected to each server. This information allows the communication architecture to control the following features, Dynamic load balancing, redundancy and geographic distribution of the virtual meter server.

Dynamic load balancing is a method to allow multiple servers to connect to new users depending on how busy the server currently is. Redundancy is a method to allow multiple virtual meter servers to reside simultaneously on a network, such that, if a main server goes down for any reason, the backup server passes all information to the other corresponding on-line server(s). Geographic distribution is the ability to locate servers locally on a network over a Wide Area Network.

Virtual postage metering system 10 uses distributed processing for load balancing the servers at Data Center 30 to improve performance. The communications servers accept requests for service from each PC 20 accessing Data Center 30. Function servers are registered upon startup. The communications servers select a function server for processing the service request. The service request is added to the function server's wait queue. When the function servers reaches 80% utilization, another function server is spawned and registered with the active servers. The function servers check the

wait queue for service requests and process these requests. Idle function or communication servers are unregistered and shutdown, removing them from the active servers list. Database servers are registered to accept database requests similarly to function servers. Multiple servers are running simultaneously to handle the workload.

It will be understood that although the embodiments of the present invention are described as postage metering systems, the present invention is applicable to any value metering system that includes transaction evidencing, such as monetary transactions, item transactions and information transactions. While the present invention has been disclosed and described with reference to a single embodiment thereof, it will be apparent, as noted above, that variations and modifications may be made therein. It is, thus, intended in the following claims to cover each variation and modification that falls within the true spirit and scope of the present invention.

Personal Post Office is a trademark of Pitney Bowes Inc.

What is Claimed is:

1. A method for evidencing postage on a mailpiece comprising the steps of:

receiving at a data center postal information relating to a mailpiece, said postal information including recipient address information for the mailpiece;

generating a digital token for the mailpiece, said digital token including encrypted information for the mailpiece based on said recipient address information;

creating a transaction record, said transaction record including the digital token and the postal information;

signing the transaction record;

storing the transaction record in a database; and

performing value added services using the transaction record.

2. A system for dispensing postage value, comprising:

a data center communicatively coupled to a plurality of remote processors, said remote processors initiating requests to the data center for dispensing postage value to be printed by a printer controlled by the remote processor, the data center comprising:

means for communicating with the remote processors, said communicating means receiving said requests for dispensing postage value;

means coupled to the communicating means for storing data records, said data records including user account information and meter account information associated with a plurality of users of users accessing the data center through said remote processors;

means coupled to the communicating means and the storing means for metering using said user account information and said meter account information; and

means coupled to the communicating means, the storing means and the metering means for performing administrative functions within the data center.

3. The system of claim 2 wherein the communicating means includes a communication server, the storage means includes a database server, the means for performing administrative functions includes a function server, and said metering means includes a secure meter box.

4. The system of claim 3 wherein each user has at least one meter account, each said meter account being assigned to one of the users accessing the data center.

5. The system of claim 3 wherein said secure meter box and said function server control the dispensing of postage value from each said meter account.

6. The system of claim 3 wherein said administrative functions include creating and signing transaction records which are stored at said database server, each of said records corresponding to each postage dispensing transaction.

7. The system of claim 6 wherein said function server provides value-added services, said value-added services including on-line rating, special mail services, address cleansing and postal coding services.

8. The system of claim 6 wherein said administrative functions include performing on-line track of all postal transaction processed by the data center.

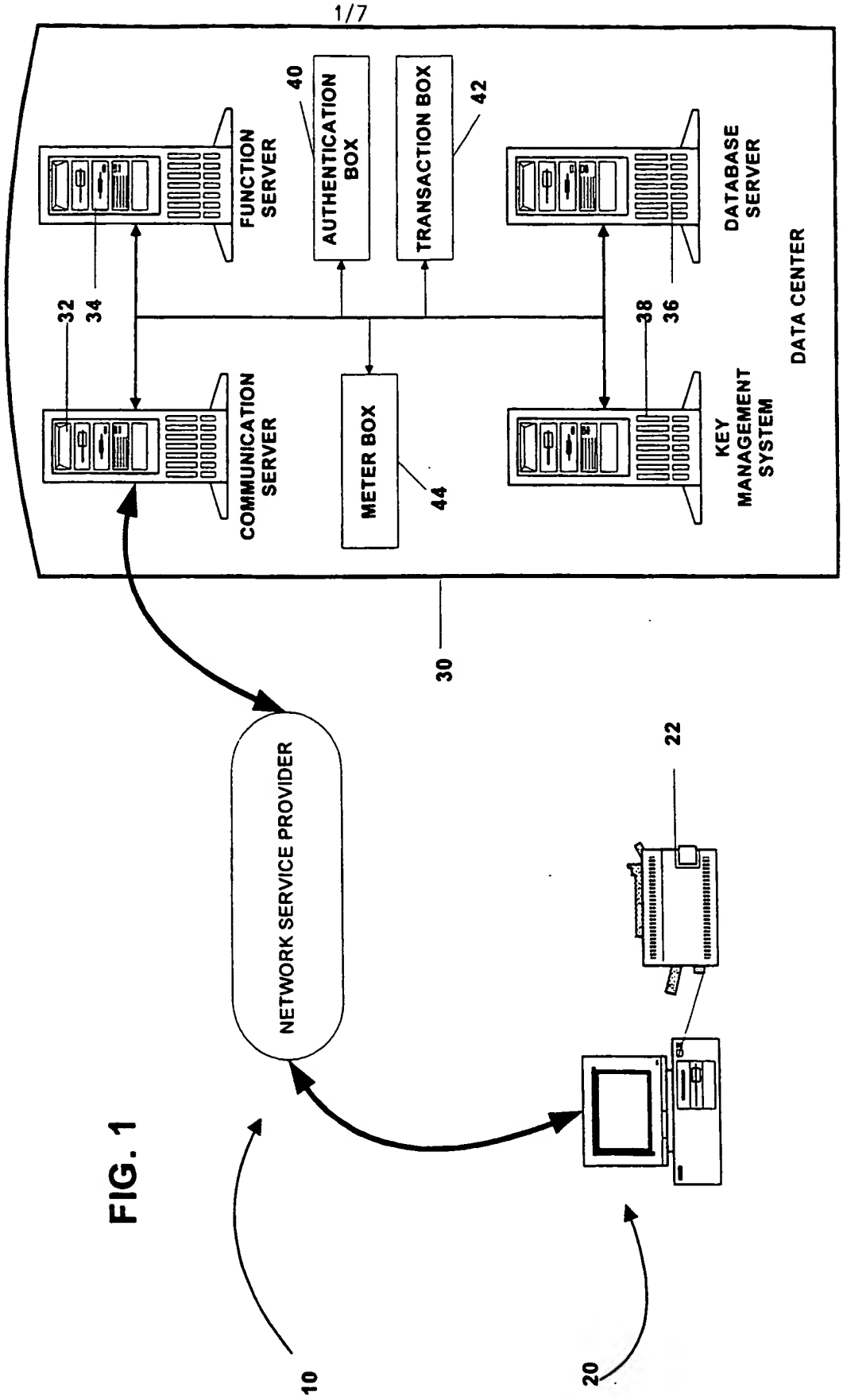
DATA CENTER
FUNCTION SERVER
AUTHENTICATION BOX
TRANSACTION BOX
DATABASE SERVER
COMMUNICATION SERVER
METER BOX
KEY MANAGEMENT SYSTEM
NETWORK SERVICE PROVIDER
10
20
22
30
32
34
36
38
40
42
44

FIG. 1

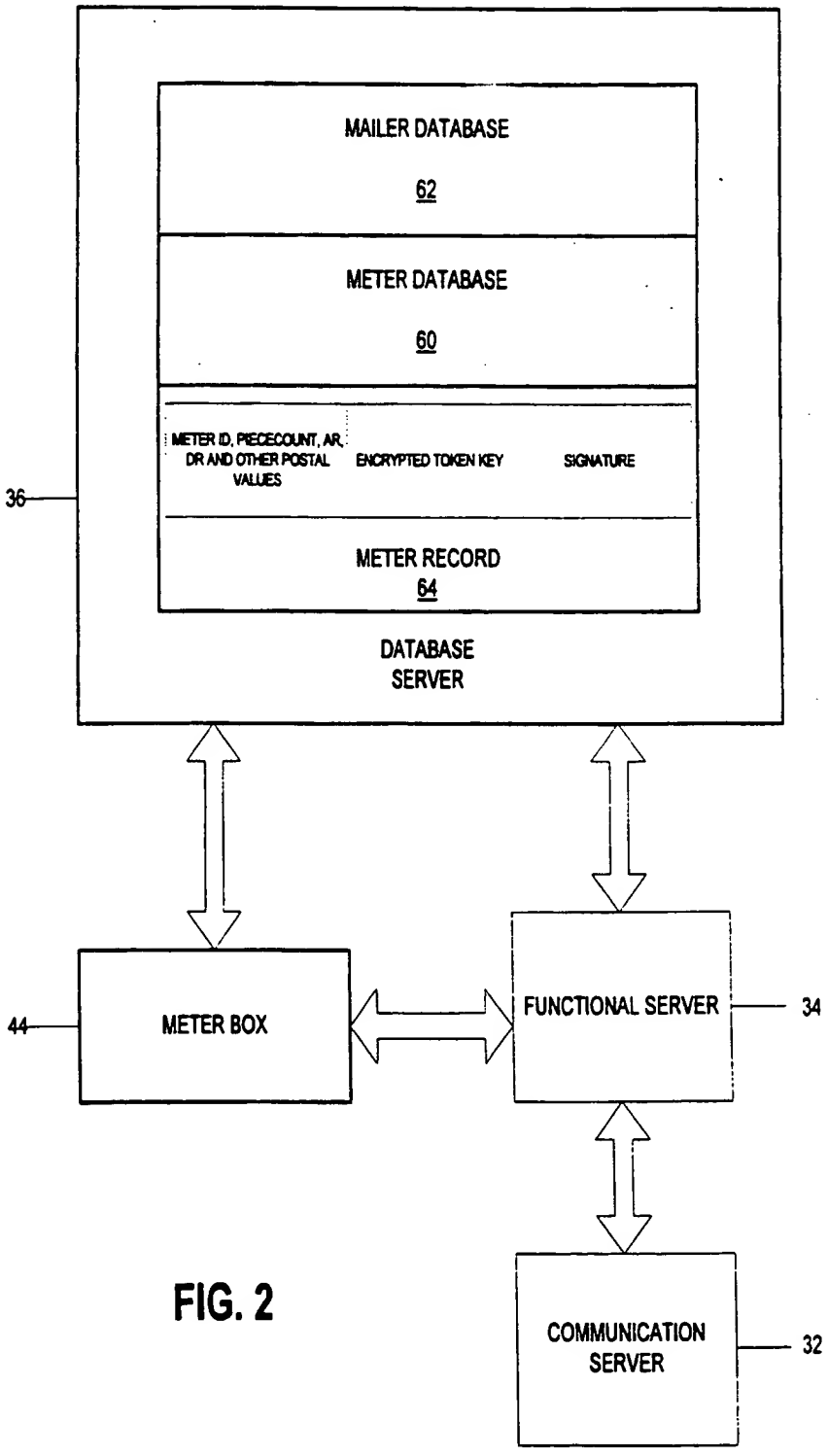
MAILER DATABASE
62
METER DATABASE
60
METER ID, PIECECOUNT, AR, DR AND OTHER POSTAL VALUES
ENCRYPTED TOKEN KEY
SIGNATURE
METER RECORD
64
DATABASE SERVER
36
METER BOX
44
FUNCTIONAL SERVER
34
COMMUNICATION SERVER
32

FIG. 2

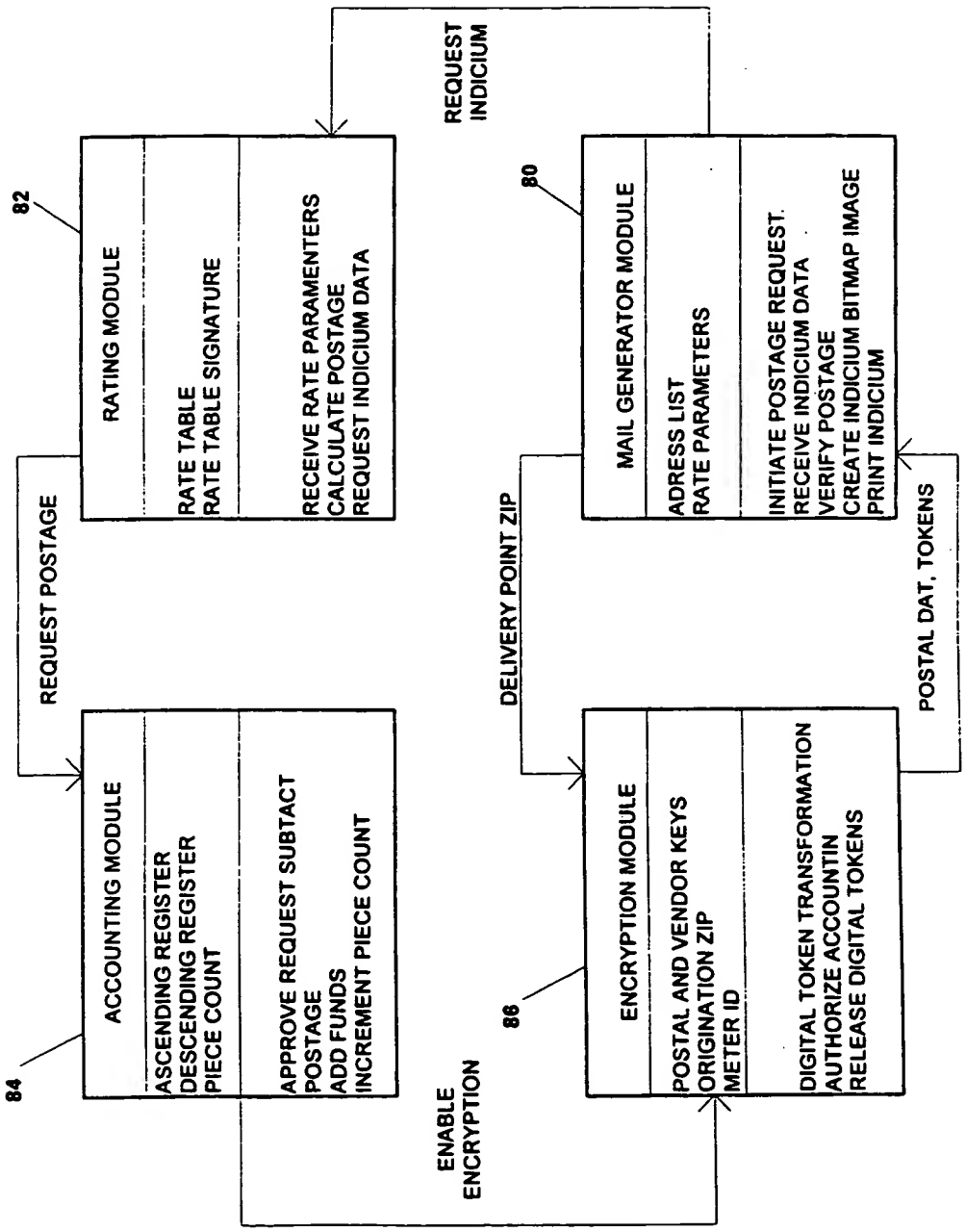
82
RATING MODULE
RATE TABLE
RATE TABLE SIGNATURE
RECEIVE RATE PARAMENTERS
CALCULATE POSTAGE
REQUEST INDICIUM DATA
REQUEST INDICIUM
80
MAIL GENERATOR MODULE
ADRESS LIST
RATE PARAMETERS
INITIATE POSTAGE REQUEST
RECEIVE INDICIUM DATA
VERIFY POSTAGE
CREATE INDICIUM BITMAP IMAGE
PRINT INDICIUM
REQUEST POSTAGE
DELIVERY POINT ZIP
POSTAL DAT, TOKENS
84
ACCOUNTING MODULE
ASCENDING REGISTER
DESCENDING REGISTER
PIECE COUNT
APPROVE REQUEST SUBTACT
POSTAGE
ADD FUNDS
INCREMENT PIECE COUNT
86
ENCRYPTION MODULE
POSTAL AND VENDOR KEYS
ORIGINATION ZIP
METER ID
DIGITAL TOKEN TRANSFORMATION
AUTHORIZE ACCOUNTIN
RELEASE DIGITAL TOKENS
ENABLE
ENCRYPTION

FIG. 3

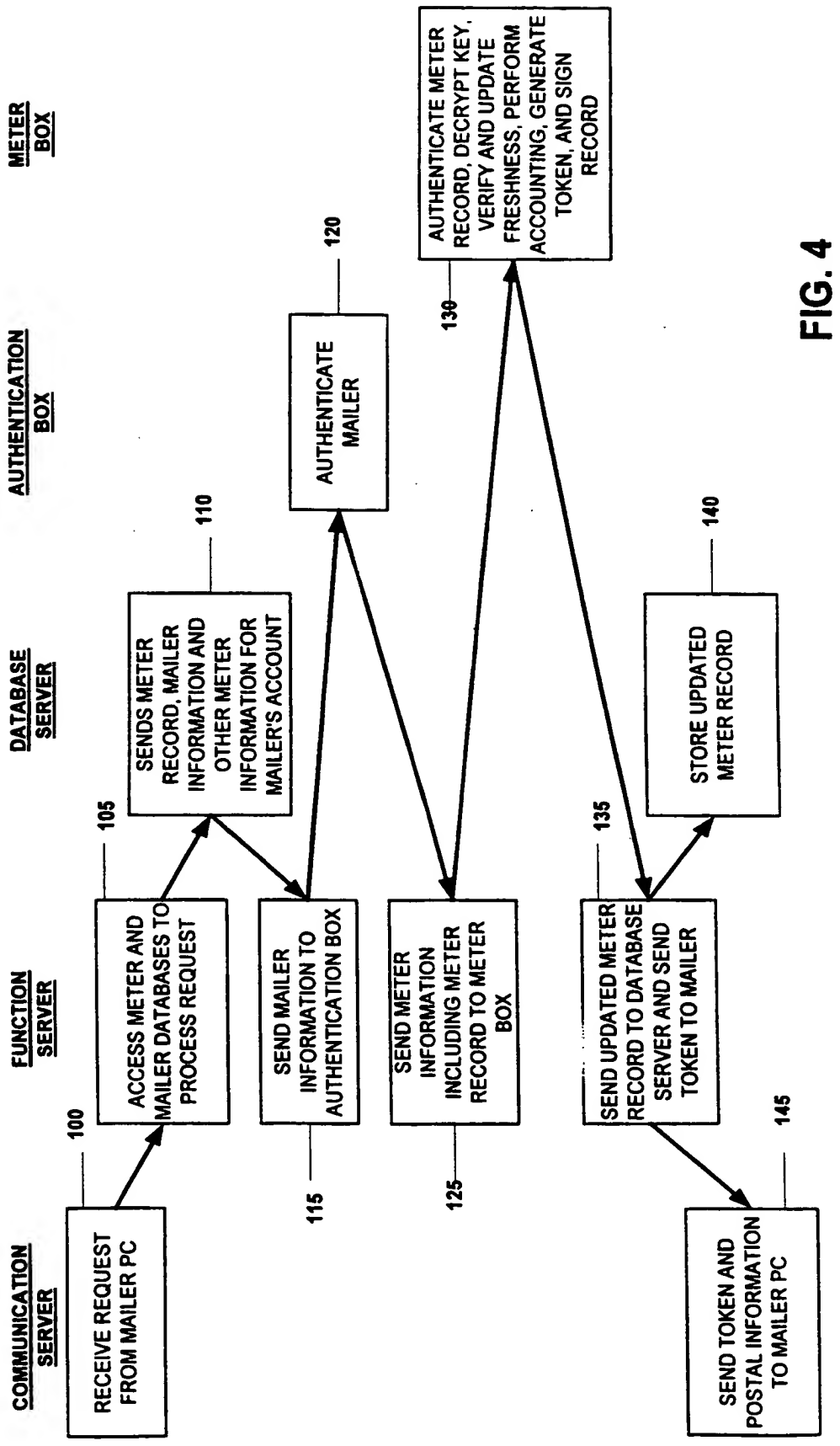
COMMUNICATION SERVER
FUNCTION SERVER
DATABASE SERVER
AUTHENTICATION BOX
METER BOX
RECEIVE REQUEST FROM MAILER PC
100
ACCESS METER AND MAILER DATABASES TO PROCESS REQUEST
105
SENDS METER RECORD, MAILER INFORMATION AND OTHER METER INFORMATION FOR MAILER'S ACCOUNT
110
SEND MAILER INFORMATION TO AUTHENTICATION BOX
115
AUTHENTICATE MAILER
120
SEND METER INFORMATION INCLUDING METER RECORD TO METER BOX
125
AUTHENTICATE METER RECORD, DECRYPT KEY, VERIFY AND UPDATE FRESHNESS, PERFORM ACCOUNTING, GENERATE TOKEN, AND SIGN RECORD
130
SEND UPDATED METER RECORD TO DATABASE SERVER AND SEND TOKEN TO MAILER
135
STORE UPDATED METER RECORD
140
SEND TOKEN AND POSTAL INFORMATION TO MAILER PC
145

FIG. 4

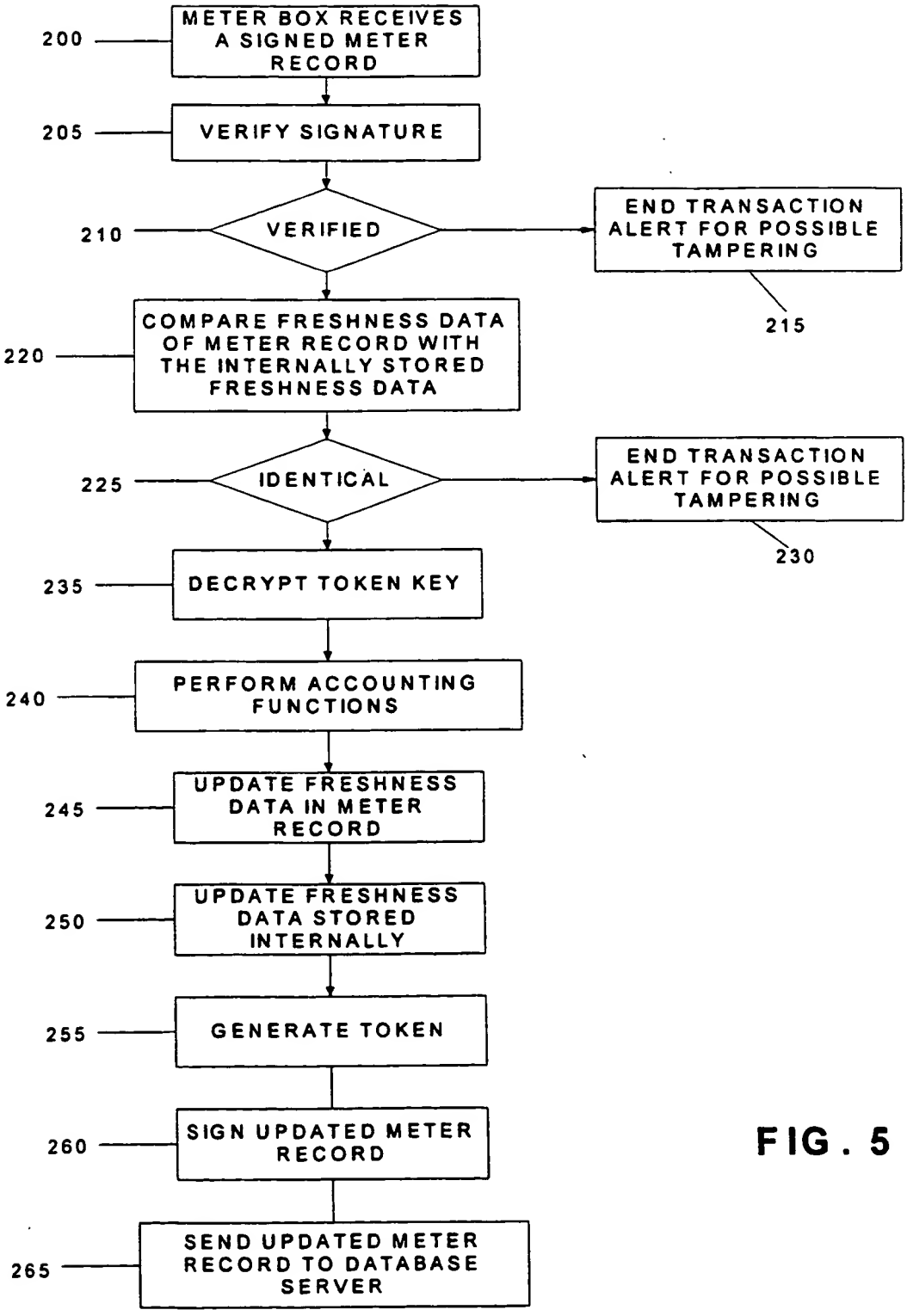
200
METER BOX RECEIVES A SIGNED METER RECORD
205
VERIFY SIGNATURE
210
VERIFIED
END TRANSACTION ALERT FOR POSSIBLE TAMPERING
215
220
COMPARE FRESHNESS DATA OF METER RECORD WITH THE INTERNALLY STORED FRESHNESS DATA
225
IDENTICAL
END TRANSACTION ALERT FOR POSSIBLE TAMPERING
230
235
DECRYPT TOKEN KEY
240
PERFORM ACCOUNTING FUNCTIONS
245
UPDATE FRESHNESS DATA IN METER RECORD
250
UPDATE FRESHNESS DATA STORED INTERNALLY
255
GENERATE TOKEN
260
SIGN UPDATED METER RECORD
265
SEND UPDATED METER RECORD TO DATABASE SERVER

FIG. 5

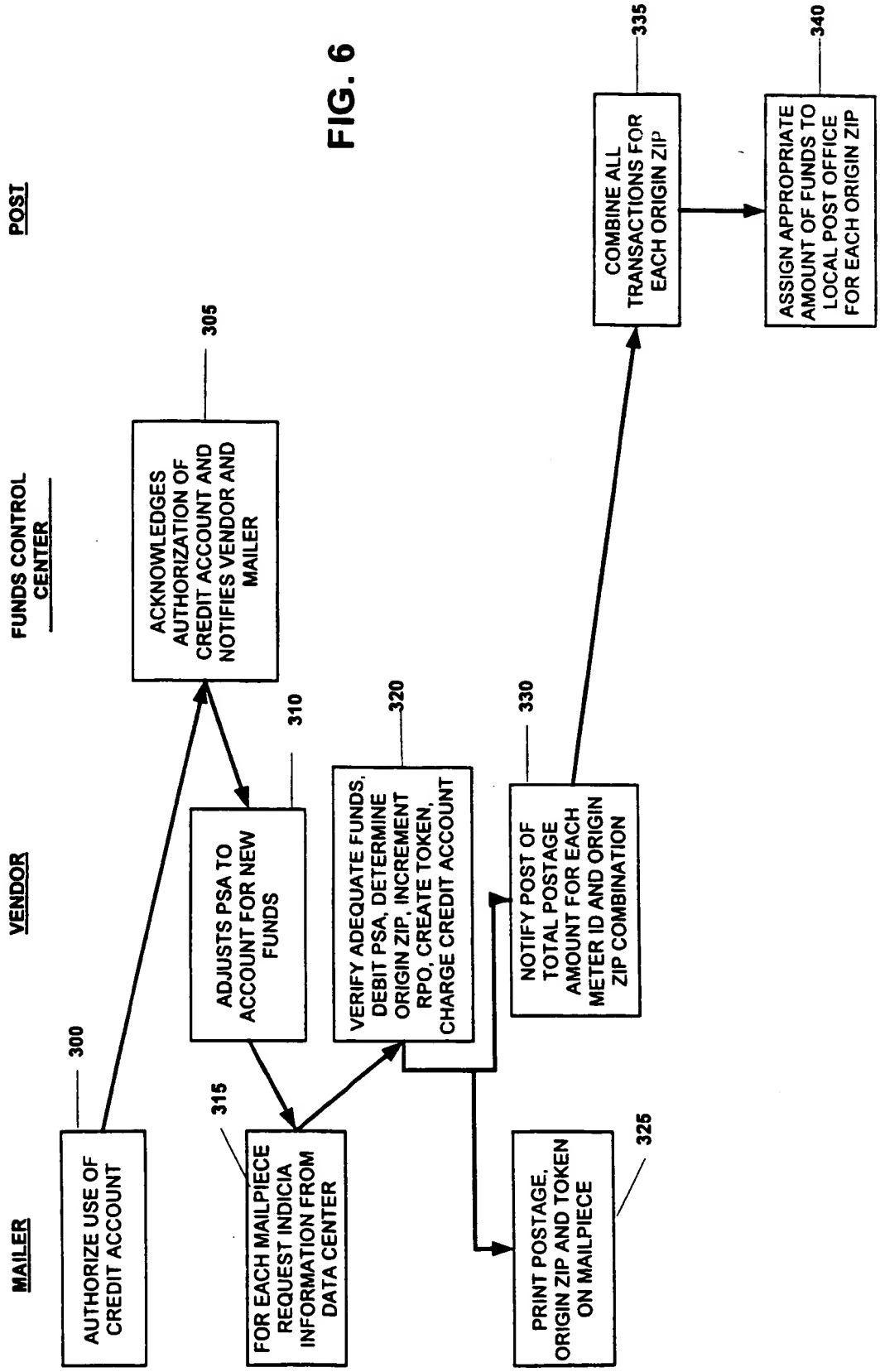
MAILER
VENDOR
FUNDS CONTROL CENTER
POST
AUTHORIZE USE OF CREDIT ACCOUNT
300
ACKNOWLEDGES AUTHORIZATION OF CREDIT ACCOUNT AND NOTIFIES VENDOR AND MAILER
305
ADJUSTS PSA TO ACCOUNT FOR NEW FUNDS
310
FOR EACH MAILPIECE REQUEST INDICIA INFORMATION FROM DATA CENTER
315
VERIFY ADEQUATE FUNDS, DEBIT PSA, DETERMINE ORIGIN ZIP, INCREMENT RPO, CREATE TOKEN, CHARGE CREDIT ACCOUNT
320
NOTIFY POST OF TOTAL POSTAGE AMOUNT FOR EACH METER ID AND ORIGIN ZIP COMBINATION
330
PRINT POSTAGE, ORIGIN ZIP AND TOKEN ON MAILPIECE
325
COMBINE ALL TRANSACTIONS FOR EACH ORIGIN ZIP
335
ASSIGN APPROPRIATE AMOUNT OF FUNDS TO LOCAL POST OFFICE FOR EACH ORIGIN ZIP
340

FIG. 6

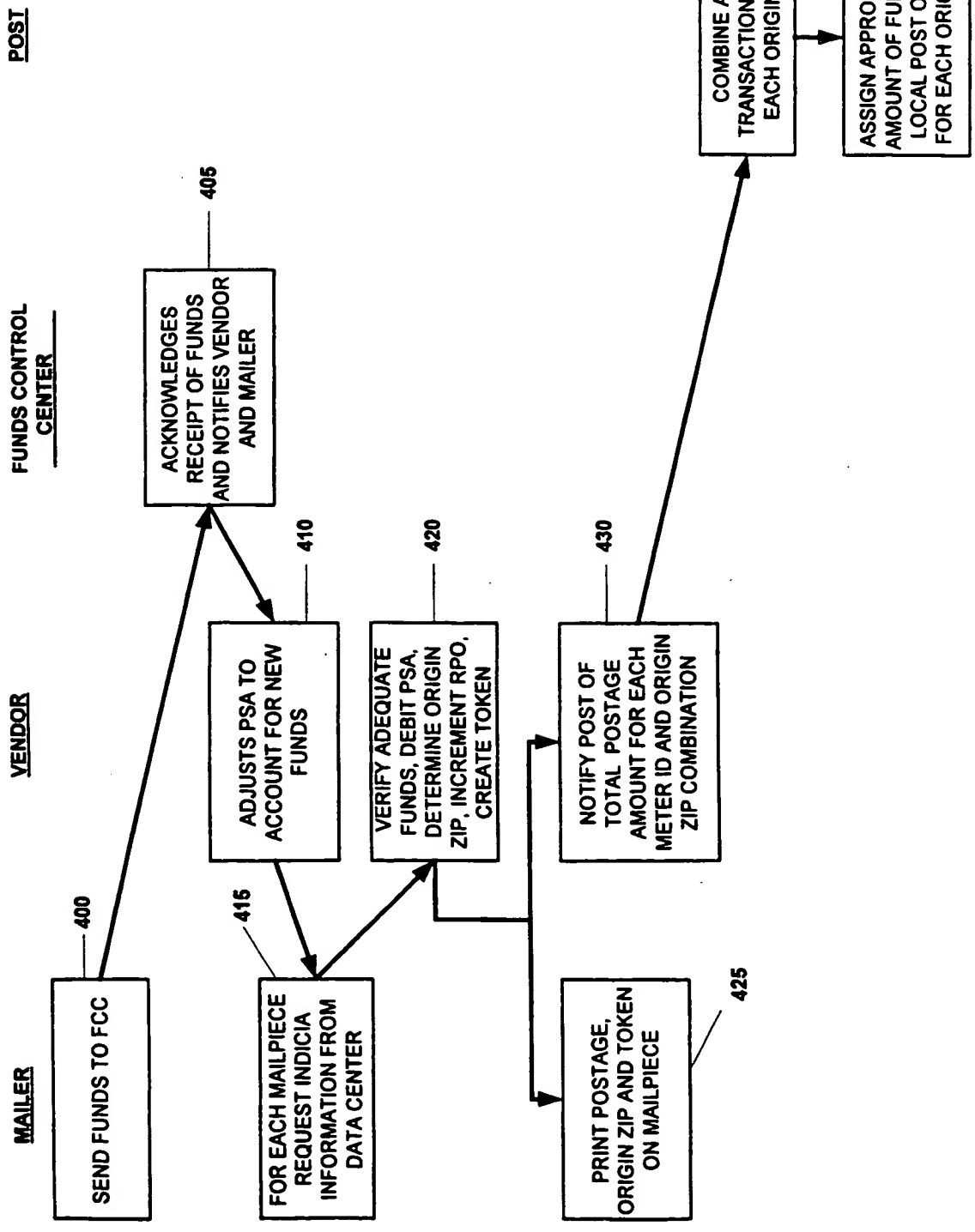
MAILER
VENDOR
FUNDS CONTROL CENTER
POST
SEND FUNDS TO FCC
400
ACKNOWLEDGES RECEIPT OF FUNDS AND NOTIFIES VENDOR AND MAILER
405
ADJUSTS PSA TO ACCOUNT FOR NEW FUNDS
410
FOR EACH MAILPIECE REQUEST INDICIA INFORMATION FROM DATA CENTER
415
VERIFY ADEQUATE FUNDS, DEBIT PSA, DETERMINE ORIGIN ZIP, INCREMENT RPO, CREATE TOKEN
420
NOTIFY POST OF TOTAL POSTAGE AMOUNT FOR EACH METER ID AND ORIGIN ZIP COMBINATION
430
PRINT POSTAGE, ORIGIN ZIP AND TOKEN ON MAILPIECE
425
COMBINE ALL TRANSACTIONS FOR EACH ORIGIN ZIP
435
ASSIGN APPROPRIATE AMOUNT OF FUNDS TO LOCAL POST OFFICE FOR EACH ORIGIN ZIP
440

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/12081

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G07B 17/00
US CL : 705/404, 410

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 340/825.35; 395/200.3, 200.33, 200.47; 705/401, 404, 410

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,873,645 A (HUNTER ET AL) 10 OCTOBER 1989, SEE ABSTRACT.	1-8
X	US 5,233,657 A (GUNTHER) 03 AUGUST 1993, SEE ABSTRACT.	1-8
A	US 5,454,038 A (CORDERY ET AL) 26 SEPTEMBER 1995, SEE ABSTRACT.	1-8
A	US 5,602,742 A (SOLONDZ ET AL) 11 FEBRUARY 1997, SEE ABSTRACT.	1-8
A	US 5,625,694 A (LEE ET AL) 29 APRIL 1997, SEE ABSTRACT.	1-8
A, P	US 5,675,650 A (CORDERY ET AL) 07 OCTOBER 1997, SEE ABSTRACT.	1-8

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents.	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search	Date of mailing of the international search report
27 SEPTEMBER 1998	19 OCT 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT	Authorized officer EDWARD R. COSIMANO

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/12081

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, P	US 5,682,429 A (CORDERY et al) 28 October 1997, see abstract.	1-8
A, E	US 5,781,634 A (CORDERY et al) 14 July 1998, see abstract.	1-8
A, E	US 5,796,841 A (CORDERY et al) 18 August 1998, see abstract.	1-8